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RICKETTSIALPOX—A NEWLY RECOGNIZED RICKETTSIAL DISEASE

V. RECOVERY OF *RICKETTSIA AKARI* FROM A HOUSE MOUSE (*MUS MUSCULUS*)¹

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Rickettsia akari, the causative agent of rickettsialpox, was isolated from the blood of persons ill with this disease (1) and from rodent mites *Allodermmanyssus sanguineus* Hirst inhabiting the domicile of ill persons (2). This paper describes the isolation of *R. akari* from a house mouse (*Mus musculus*) trapped on the same premises—a housing development in the city of New York where more than 100 cases of rickettsialpox have occurred (3), (4), (5), (6).

Approximately 60 house mice were trapped in the basements of this housing development where rodent harborage existed in store rooms and in incinerator ash pits. Engorged mites were occasionally found attached to the mice, the usual site of attachment being the rump. Mites were frequently found inside the box traps after the captured mice were removed.

Early attempts to isolate the etiological agent of rickettsialpox from these mice were complicated by the presence of choriomeningitis among them. Twelve successive suspensions of mouse tissue, representing 16 house mice, inoculated intracerebrally into laboratory mice (Swiss strain) and intraperitoneally into guinea pigs resulted in the production of a highly lethal disease in both species which was identified immunologically as choriomeningitis.

¹ From the division of Infectious Diseases, National Institute of Health.

ISOLATION OF THE HOUSE MOUSE STRAIN

Laboratory mice (Swiss strain) were immunized by subcutaneous inoculation with a sublethal dose of choriomeningitis virus. Approximately 1 month later, on October 7, 1946, saline suspensions of liver and spleen from three house mice freshly trapped at the rickettsialpox focus were inoculated respectively into three groups of the choriomeningitis-immune laboratory mice.

On October 16, one group of inoculated mice showed signs of illness; inactivity, ruffled fur, and rapid breathing. On October 17, one mouse died. Two others were sacrificed and tissues transferred to mice and guinea pigs. Both sub-passages produced the external signs and gross pathological changes typical of rickettsialpox and *R. akari* was recovered from the tissues of guinea pigs and mice.

Employing guinea pigs, reciprocal cross immunity was demonstrated between the house mouse strain and the human and mite strains. Growth of the house mouse strain in the yolk sacs of fertile eggs was initiated with tunica washings from an infected guinea pig. On successive passages the growth was abundant, and morphologically the organisms could not be distinguished from those of the human strains of *R. akari*.

Antigens prepared by ether extraction of infected yolk sacs (7) for use in the complement-fixation test (8) were of high potency and were serologically indistinguishable from antigens prepared from human strains (table 1). Titrations of pooled serum collected from guinea pigs recovered from infection with the house mouse strain are shown in table 2.

TABLE 1.—Complement fixation by house mouse and *M. K.* antigens in the presence of specified guinea-pig serums

Guinea-pig serums used in 1:16 dilution	House mouse antigen ¹ titer	<i>M. K.</i> antigen ¹ titer	Guinea-pig serums used in 1:16 dilution	House mouse antigen ¹ titer	<i>M. K.</i> antigen ¹ titer
Normal	Negative	Negative	<i>M. K.</i>	1:32	1:128
Endemic typhus	Negative	Negative	Mite No. 1	1:128	1:128
Q fever	Negative	Negative	House mouse	1:64	1:128
Rocky Mountain spotted fever	1:64	1:64			

¹ Made from 10-percent yolk-sac suspensions.

A high incidence of immunity to rickettsialpox in the mice trapped at the rickettsialpox focus was indicated by their resistance to challenge with the 10^{-1} dilution of a viable yolk-sac suspension lethal (LD_{50}) for white mice (Swiss strain) in dilutions as high as 10^{-5} . House mice (*Mus musculus*) trapped in northern Virginia were found to be susceptible to experimental rickettsialpox on a scale comparable to the susceptibility of the Swiss strain (table 3).

Evidence of immunity to rickettsialpox was also demonstrated by the complement-fixation test in serums of mice collected at a New York City focus of infection while no antibodies were found in the serums of normal laboratory mice or of house mice trapped in northern Virginia (table 4).

TABLE 2.—*Titration in the complement-fixation test of pooled serums taken from guinea pigs recovered from infection with house mouse and M. K. strains of rickettsialpox*

Antigens used in constant dilutions ¹	Titer of house mouse strain serum pool	Titer of M. K. strain serum pool	Antigens used in constant dilutions ¹	Titer of house mouse strain serum pool	Titer of M. K. strain serum pool
M. K. strain.....	1:32	1:128	Rocky Mt. spotted fever (B. R. strain).....	0	1:16
Mite strain.....	1:16	1:64	Q fever (Italian strain).....	0	0
House mouse strain.....	1:32	1:64			

¹ 2 units as determined in titration with homologous antisera.

TABLE 3.—*Comparative number of survivors among mice from specified sources after intraperitoneal challenge with a yolk-sac suspension of R. akari (M. K. strain)*

Source of mice	Number of survivors in relation to number of mice inoculated			
	Concentration of challenge materials ¹			Totals
	10 ⁻¹	10 ⁻²	10 ⁻³	
Wild house mice trapped at a focus of infection in New York City.....	5:5	3:5	5:5	13:15
Wild house mice trapped in Virginia.....	0:4	2:5	2:5	4:15
Laboratory mice (Swiss strain).....	0:5	1:5	2:5	3:15

¹ LD₅₀ titer 10⁻⁴ (skim milk used as diluent).

TABLE 4.—*Complement fixation results with serums of house mice trapped at a focus of infection ¹ and elsewhere and of white mice*

Source of mouse serums	Number of mouse serums examined in complement fixation tests ²	Number positive for rickettsialpox	Range of titers
House mice ¹ trapped at focus of infection.....	7	4 0	1:16 to 1:32.
House mice trapped in Virginia.....	6	(negative at 1:8) 0	
White mice (Swiss strain).....	10	(negative at 1:4) 2	
White mice experimentally infected with rickettsialpox ³ .	2		Both greater than 1:32.

¹ Mice were bled approximately 2 months after capture

² Bengtson technique used.

³ Bled 30 days after inoculation.

DISCUSSION

Infestations of house mice with mites (*Allodermanyssus sanguineus*) Hirst were described in a previous communication, and the ability of *A. sanguineus* to transmit rickettsialpox to experimental animals was demonstrated (2). The data presented in this paper show that the house mouse (*Mus musculus*) may harbor the infection in nature.

Immunity of mice from infected homes was also demonstrated by direct challenge and by the complement-fixation test. These findings suggest methods for the investigation of suspected foci of rodent infection.

SUMMARY

Rickettsia akari, the causative agent of rickettsialpox was recovered from the tissues of a naturally infected house mouse (*Mus musculus*) trapped at the site of an outbreak of the disease.

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PLAGUE—FIELD SURVEYS IN WESTERN UNITED STATES DURING TEN YEARS (1936-1945)¹

By N. E. WAYSON, Medical Director, United States Public Health Service

The investigations of the circumstances surrounding the death of two people from bubonic plague in July 1908, in a semirural area bordering San Francisco Bay, revealed an enzootic of plague among

¹ The surveys have been successively directed and the results recorded by H. E. Hasseltine, Medical Director; C. R. Eskey, Medical Director; L. D. Byington, Senior Surgeon; and N. E. Wayson, Medical Director.

the California ground squirrels (*Citellus beecheyi beecheyi*) of Contra Costa County, California. This discovery stimulated explorations to determine the extent to which the infection had spread, and during the succeeding 10 years, the United States Public Health Service made examinations of more than 500,000 ground squirrels collected from large areas of 31 counties in California and 5 bordering counties of Nevada and Oregon. The squirrels, or rats, of 11 counties were found to be infected. Similar surveys of very much less scope and intensity were continued until 1927 by the United States Public Health Service, and subsequently by the California State Department of Health. In 1934, two sharp outbreaks of plague occurred among ground squirrels in Kern County, and among ground squirrels and wood rats (*Neotoma cinerea*) of Modoc County, both of California. These two counties are approximately 200 miles north and 200 miles south, respectively, of the Sacramento River, which had formerly been considered a barrier to the northern extension of the infection. Modoc County is at the northern boundary of California and borders on Lake County of Oregon. These two outbreaks were followed by an expansion of the investigations in California by the board of health, and during the past 10 years, infection has been found in ground squirrels and in a few rodents of other genera from 17 other counties. Over the entire period of 37 years, infected animals or parasites have been collected in 33 of the 58 counties of the State.

Also in 1934, a sheepherder died of bubonic plague in Lake County, Oregon, which adjoins Modoc County, California. In the spring of 1935, the United States Public Health Service equipped a field party with a mobile laboratory and made collections and examinations of animals of Lake County, of a few adjoining counties in Oregon, of some adjacent counties in Nevada, and of 10 counties in California. Infection was found in ground squirrels (*Citellus columbianus* and *Citellus beldingi oregonus*) in three counties of Oregon. During the same year, infection was discovered also in three Richardson ground squirrels which were found dead, or sick, in Montana and were submitted for examination by collaborating officials. These discoveries suggested the necessity of extending the surveys to other States. From two to nine field parties of the Public Health Service have continued the investigations annually, with collaboration by the health departments of Washington, Oregon, Idaho, Montana, and Utah.

FLEAS AS INDEX OF PLAGUE

Studies in 1915 in this laboratory demonstrated that plague could be discovered in an area in which there was no record of recent infection

among the rodents. Fleas collected from burrows or animals in such an area, shipped for a short distance to the laboratory, and anaesthetized to facilitate handling, remained alive for periods of 14 to 21 days under a quarantine, and transmitted the disease to animals by biting.

These facts were put into practical use with the beginning of the field operations in 1936, and have been shown to be so valuable an adjunct to the discovery of plague in rodents that they have been continued throughout the past 10 years.

EXTENT OF SURVEYS

During this period (1936-45), surveys varying in extent from as little as 10 to as much as 1,000 square miles have been made in each of 487 counties of a total of 644 counties between the Pacific Coast and the 100th meridian, and the Canadian and Mexican boundaries, in 17 western States. This area constitutes approximately 40 percent of continental United States. In general, the surveys have been limited to locations which could be reached by roads, and to the surroundings of communities which were served by railroad or other nearby shipping facilities. The areas from which collections were made were but a small portion of the total areas surveyed.

The surveys were made by units of two men of practical experience in hunting and trapping, who were trained in the dissection of animals, the recognition of the pathology of plague, the identification and classification of animals and their habits and range, the collection of animal parasites, and in the preparation and shipment of specimens for final tests. The unit had a mobile laboratory of a panel truck which was equipped with all the accoutrements and facilities necessary to make and examine collections of animals and to prepare and ship specimens of tissues or fleas for bacteriological tests throughout a season of from 6 to 8 months. All the collected parasites and the selected specimens of tissue were subjected to differential bacteriological and pathological tests at the central laboratory at San Francisco, Calif. More than 595,097 rodents, 1,186,777 fleas, and a small number of other animals and parasites have been collected and examined; and 461 specimens of tissues or of fleas have been found infected with plague. These specimens were obtained from 70 counties, which are scattered throughout the area as far eastward as western North Dakota, Kansas, and Oklahoma, and are exclusive of the State of California. The State Health Department of California has conducted similar operations throughout the 10 years, though with differences in procedures and accounting. It reports plague in the following specimens: Tissues of 828 field rodents, 9 Norway

rats, 80 pools of the tissues of several rodents, and 492 pools of rodent fleas, collected from 33 of the 58 counties of California between 1927 and 1945.

VARIETY OF ANIMALS INFECTED

The animals collected and examined by the Public Health Service were of 45 genera of 5 orders—Marsupiala, Insectivora, Carnivora, Rodentia, and Lagomorpha—and a few specimens of bats (Chiroptera) hawks and owls (Raptore). Twenty-six species of the genus and subgenera of *Citellus* were included. Plague was found in tissues and in fleas of nine species of ground squirrels (*Citellus armatus*, *beecheyi beecheyi*, *beldingi*, *columbianus*, *richardsonii*, *townsendii*, *tridecemlineatus*, *variegatus*, *washingtoni*), and in fleas infesting three other species (*Citellus beecheyi douglasii*,² *idahoensis*, *lateralis*). Specimens of tissue of eight other genera, and of their infesting fleas, were also found to be infected: prairie dogs (*Cynomys*), kangaroo rats (*Dipodomys*), marmots (*Marmota*), meadow mice (*Microtus*), wood or pack rats (*Neotoma*), grasshopper mice (*Onychomys*), rats (*Rattus*), and cottontail rabbits (*Sylvilagus*). Infected fleas were taken also from chipmunks (*Eutamias*), weasels (*Mustela*), deer mice (*Peromyscus*), harvest mice (*Reithrodontomys*), cotton rats (*Sigmodon*) and badgers (*Taxidea*) (table 1). The infected specimens consisted of 153 tissues or pools³ of tissues, and 308 pools of fleas.

Aside from those of the genus *Sylvilagus*, all the infected animals were of the rodentia, though it may be remarked that relatively few individuals of other orders were captured.

Infected specimens of tissue only were found in 8 counties, infected fleas only in 37, and both infected tissues and fleas in 25. Thus, there were 33 counties in which infected tissues were found, and 37 in which only infected fleas were found.

Previous to 1935, attention was restricted to ground squirrels almost exclusively, but after this date and more particularly during the past 5 years, emphasis has been put on the collection of other rodents. The relative incidence of plague found among the latter has been 12 specimens of tissue and 62 specimens of fleas among 188,815 animals, exclusive of prairie dogs (*Cynomys*) and rats (*Rattus*). Prairie dogs are excepted because of their habits of colonization and hibernation, which are similar to those of ground squirrels. Rats are excepted because the larger number of them were taken in cities or towns and

¹ Infection has been found in *C. beecheyi douglasii* in California.

² A pool of tissue is a portion of the tissues of each of several animals of the same species, collected at one hunting area on the same day. A pool of fleas is the total obtained from all the animals of the same species collected at one hunting area in 1 to 3 days. A hunting area is a specific district in a city, or an area of 5 to 25 square miles in the country.

TABLE 1.—Specimens of mammals collected during plague surveys, 1936-1945 by order and genera (Anthony); and subgenera and species of *Citellus* (Howell)

[Those in which plague was found are marked with P and those from which only infected fleas were collected are marked PF.]

Order	Genus	Order	Genus	Genus	P
Carnivora.....	<i>Canis</i>	Rodentia	<i>Aplodontia</i>	<i>Neotoma</i>	P
	<i>Felis</i>		<i>Castor</i>	<i>Ondatra</i>	P
	<i>Mephitis</i>		<i>Citellus</i>	<i>Onychomys</i>	P
	<i>Mustela</i>		<i>Cynomys</i>	<i>Perognathus</i>	PF
	<i>Procyon</i>		<i>Dipodomys</i>	<i>Peromyscus</i>	PF
	<i>Spilogale</i>		<i>Erethizon</i>	<i>Phenacomys</i>	P
	<i>Taxidea</i>		<i>Eutamias</i>	<i>Rattus</i>	P
Insectivora.....	<i>Vulpes</i>		<i>Erotomys</i>	<i>Reithrodontomys</i>	PF
	<i>Blarina</i>		<i>Geomys</i>	<i>Sciurus</i>	PF
	<i>Cryptotis</i>		<i>Glaucomys</i>	<i>Sigmodon</i>	PF
	<i>Neurotrichus</i>		<i>Marmota</i>	<i>Synaptomys</i>	
	<i>Scapanus</i>		<i>Microtus</i>	<i>Thomomys</i>	
Lagomorpha.....	<i>Sorex</i>		<i>Mus</i>	<i>Zapus</i>	
	<i>Brachylagus</i>				
Marsupialia.....	<i>Lepus</i>				
	<i>Ochotona</i>				
	<i>Sylvilagus</i>				
	<i>Didelphis</i>				

Citellus—Genus

Subgenus	Species	Subgenus	Species
<i>Citellus</i>	<i>armatus</i>	<i>Ictidomys</i>	<i>mexicanus</i>
	<i>beldingi</i>		<i>spilosoma</i>
	<i>columbianus</i>		<i>tridecemlineatus</i>
	<i>idahoensis</i>	<i>Otospermophilus</i>	<i>beecheyi</i>
	<i>richardsonii</i>		<i>variegatus</i>
	<i>townsendii</i>	<i>Pollocitellus</i>	<i>franklinii</i>
	<i>washingtoni</i>	<i>Xerospermophilus</i>	<i>mohavensis</i>
<i>Ammospermophilus</i>	<i>harrisi</i>		<i>tereticaudus</i>
<i>Callospermophilus</i>	<i>interpres</i>		
	<i>leucurus</i>		
	<i>lateralis</i>		
	<i>saturatus</i>		

in their immediate environs. Eleven tissue specimens and thirty-eight flea specimens were found infected among a collection of 85,414 prairie dogs. One infected Norway rat was found in San Francisco, California, and 37 specimens of tissues and 64 pools of fleas were infected among those of rats trapped in Tacoma, Washington.⁴

FLEA VECTORS AND "FLEA INDEX"

The collection of fleas included 1 or more species of 53 genera, but neither the classification and distribution of all the species, nor their role in the transmission of the disease has been determined. Under laboratory conditions, 36 species have become infected, and 19 of them have proven to be capable vectors. Other investigators have reported infection in seven additional species which are common to the area surveyed, and transmission of the disease by five of these (table 2).

The number of fleas recovered per animal, the flea index, varied with location, season, and species of animal. Among rodents which have been found infected, the indices from the over-all collections are: *Dipodomys*, collection 38,277, index 0.2; *Microtus*, collection 16,493, index 0.87; *Onychomys*, collection 16,876, index 1.0; *Cynomys*, collection 85,414, index 3.0; *C. Variegatus*, collection 2,411, index 11.2;

⁴ Plague was also found during this period in rats or their fleas in communities about San Francisco Bay, by the California State Health Department.

TABLE 2.—Specimens of fleas collected, by genera, and species proven to be vectors

<i>Actenophthalmus</i>	<i>Ctenophyllus</i>	<i>Megabothris</i>	<i>Phalacroscylla</i>
<i>Amphalius</i>	<i>Dactylopsylla</i>	<i>Megarhroglossus</i>	<i>Pleochaetis</i>
<i>Anomiopsyllus</i>	<i>Dasypsyllus</i>	<i>Meringia</i>	<i>Pulex</i>
<i>Athyloceras</i>	<i>Diamanus</i>	<i>Micropsylla</i>	<i>Rectofrontia</i>
<i>Callistopsyllus</i>	<i>Dolochopsyllus</i>	<i>Monopsyllus</i>	<i>Rhinolopsyllus</i>
<i>Carteretta</i>	<i>Doratsylla</i>	<i>Myodopsyllus</i>	<i>Rhopalopsyllus</i>
<i>Catallagia</i>	<i>Echidnophaga</i>	<i>Nearctopsylla</i>	<i>Stenistomera</i>
<i>Cediopsylla</i>	<i>Epiledia</i>	<i>Nosopsyllus</i>	<i>Stenoponia</i>
<i>Ceratophyllus</i>	<i>Fozella</i>	<i>Odontopsyllus</i>	<i>Thrassis</i>
<i>Conorhinopsylla</i>	<i>Geusibia</i>	<i>Opisocrostis</i>	<i>Trichopsylloides</i>
<i>Coropsylla</i>	<i>Hoplopsyllus</i>	<i>Opisodasys</i>	<i>Xenopsylla</i>
<i>Corypsylloides</i>	<i>Hystrihopsylla</i>	<i>Orchopeas</i>	
<i>Ctenocephalides</i>	<i>Leptopsylla</i>	<i>Oropsylla</i>	
<i>Ctenophthalmus</i>	<i>Malareus</i>	<i>Peromyscopsylla</i>	

Flea vectors

<i>Athyloceras multidentatus</i> (5) ¹	<i>Monopsyllus eumolpi</i> (2)	<i>Thrassis acamantis</i> (2)
<i>Ctenocephalides canis</i> (1)	<i>Nosopsyllus fasciatus</i> (2)	<i>Thrassis arizonensis</i> (2)
<i>Ctenocephalides felis</i> (1)	<i>Orchopeas sexdentatus</i> (2)	<i>Thrassis bacchi</i> (4)
<i>Diamanus montanus</i> (2)	<i>Opisocrostis bruneri</i> (4)	<i>Thrassis fatus</i> (5)
<i>Hoplopsyllus anomalus</i> (2)	<i>Opisocrostis hirsutus</i> (2)	<i>Thrassis francisi</i> (2)
<i>Hystrihopsylla dippei</i> (5)	<i>Opisocrostis labis</i> (2)	<i>Thrassis howelli</i> (2)
<i>Leptopsylla segnis</i> (1)	<i>Opisocrostis tuberculatus</i> (2)	<i>Thrassis pandorae</i> (2)
<i>Malareus telchinum</i> (3)	<i>Oropsylla rupestris</i> (2)	<i>Xenopsylla cheopis</i> (2)
	<i>Pulex irritans</i> (1)	

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Marmota, collection 4,465, index 13.5. Indices for other ground squirrels are of the order of 3.0, except those of *C. beecheyi beecheyi* and *C. beecheyi douglasii*, which are of the order of *C. variegatus* (11 to 14). There is no evidence of a correlation between the indices of sick and normal animals either from the same area or from similar areas. Nor is the seasonal variation found during some years consistent, either annually or in different locations during the same year. The indices have been determined by collecting and examining the larger rodents promptly after they had been killed, whereas the smaller rodents were examined after they had lain in a dead-fall trap for 12 hours or longer. Numerous experiences indicate that animals trapped alive and collected some hours later frequently have a lower index than those killed quickly. This may be due in part to the struggles of the live animal to release itself. However, 50 to 60 percent of hungry fleas placed on a contented live animal under controlled conditions deserted it within 16 hours. On the other hand, animals collected 12 hours or longer after having been killed in a deadfall trap have occasionally had from 200 to 900 fleas on them. The lack of correlation between the flea index and the number of fleas to which the animal is exposed

is exemplified by the observation of an index of 3.0 among 500 trapped animals, whereas each of 13 of their nearby nests contained over 1,000 fleas. It may be noted also that an index of less than one does not eliminate the probability of dissemination of infection. One flea infected with plague has transmitted the infection to each of several animals when afforded the opportunity. This condition may occur in the nests of young animals, and amongst the dense population in the burrows of colonizing animals.

The facility with which different species of fleas transmit the infection under experimental conditions varies greatly. One factor which may influence the variation is the length of time which is required, apparently, for the development of the condition within the flea which effects or aids in transmission. This may occur within 5 to 10 days in *Xenopsylla cheopis*, the Indian rat flea, and under like conditions has occurred usually only after 15 days in *Nosopsyllus fasciatus* (the rat flea common to the Pacific Coast States). Individuals of other species have failed in transmission during repeated opportunities for as long as 3 months after having fed on an infected animal, but have then been successful. There are doubtless other factors concerned. Thus, 1,168 trials to infect an animal through feedings with 148 specimens of *Malareus telchinum*, a flea common to the meadow mouse, were unsuccessful under conditions in which each individual flea was under constant control, whereas transmissions by this species occurred when 50 to 100 of the fleas were placed on their natural host in a noninfected environment but without further controls.

Various species of fleas exhibit some degree of specificity in the choice of their hosts, and it would seem that this flea-host selectivity might at least retard if not restrict the dissemination of infection from an animal of one genus to that of another. However, hungry fleas will feed avidly on hosts of each of several genera, and species of fleas which are very efficient vectors frequently infest a host whose specific flea is a poor vector. Fleas of two or three genera are often found on an animal. Dissemination of plague vectors to animals of different genera may be aided also by the habits of a host such as the grasshopper mouse (*Onychomys*), which is a meddlesome rodent that visits burrows and nests of animals of other genera. This mouse is often infested with fleas which are specific to each of several other rodents, and collects and perhaps spreads these several varieties of fleas during its visits.

SEASONS AND GEOGRAPHY OF PLAGUE

The collections of field animals have been made for the most part during the seasons in which the weather permits of travel and of the

more profitable hunting and trapping of the various rodents, including those which hibernate during periods of cold, snow, and winter rains. This season extends from about the 1st of March through September. Specimens with plague have been found during each month of the season. The greatest number has been collected in July, about half as many in each of the months from April to August, and about one-quarter as many in each of March and September. Infected meadow mice (*Microtus*) and infected fleas of deer mice (*Peromyscus*), as well as infected specimens of tissue and fleas of rats (*Rattus*) have been collected during December on the Pacific slope in Washington.⁵

The period during which plague will persist in rodents of a given area has not been determined by systematic investigations under properly controlled circumstances. Plague has been found in specimens collected from one locality during each of four successive animal seasons, and, on the other hand, plague has been found in one season and has not been found during four successive seasons, although adequate collections have been made from the same farms and surroundings on which it had been discovered previously. It has not been uncommon to find plague in the same locality during two successive seasons. During the past 5 years, the surveys have been directed with the purpose of learning whether the infection is extending into territory in which it has not previously extended, insofar as can be determined. Collections have been made in some of the latter areas in each of three or more years without finding any infection, but after these repeated negative results it has been found in later years.

Neither the persistence of a focus of infection from year to year, nor its primary discovery has shown any correlation with the total population of the rodents or the flea index, or with the number of animals examined above a minimum sample of one hundred.

Infected rodents and fleas have been found in areas at sea level and in those intervening areas up to an altitude as high as 9,000 feet, between the parallel of latitude 30° N. to the Canadian boundary. (Canadian authorities have reported the presence of infected rodents as far north as latitude 52° N.) The terrains of these collections have been deserts, grasslands, mountain meadows, rock ledges, fringes of cultivated areas which may or may not be irrigated, banks of streams, and rights-of-way along railroads and highways. The interior of forests and of large cultivated acreages without barren spots have not yielded positive results.

⁵ Infected ground squirrels and fleas have been collected by the California State Health Department on the Pacific slope in California during the winter months. The young squirrels do not hibernate throughout the winter months in some areas of California.

DISCUSSION

Investigations of the circumstances which may influence the epizootology and epidemiology of plague have been carried on concurrently in the field and in the laboratory.

All of the laboratory studies confirm previous findings that *Pasteurella pestis*, the specific cause of plague, exhibits consistent characteristics which do not permit of differentiation of strains recovered from rats, from other rodents, from fleas, or from man. These investigations have also established the fact that each of a number of species of fleas may serve as vectors of the disease for different rodent hosts. Fleas of some species do not become infectious as rapidly as those of others under experimental surroundings, and some feed with greater avidity than others on host species which are accidental and not specific to them.

It is evident that foci of bubonic plague among rodents of several genera are widely scattered throughout the area within the north and south boundaries of the United States, and from the Pacific Ocean to approximately the 102d meridian W.⁶ The extent and number of foci have not been determined by the limited resources available and the methods necessarily applied, but that which has been determined suggests that both the extent and number of foci are greater than those recorded. It appears also that the infection is enzootic in these areas, and that it has spread easterly from the Pacific Coast. The rapidity of dissemination which has occurred cannot be estimated, but it seems likely that further advancement eastward will be slow, and in terms of years.

Shortly after it was discovered that ground squirrels were infected in California, extensive examinations were made, over the course of a few years, of the rodents in counties north of the Sacramento River, and in the southern counties which were more remote from the San Francisco area. Infection was not found among them. Ten to fifteen years later, squirrels which were collected from both northern and southern counties were found to be infected. After it was learned in 1936 that animals were infected in other western states, the examinations were extended to all of the Rocky Mountain States as far as the Great Plains. No infection was found in the eastern portion of the Rocky Mountain States nor in the Plains States after repeated surveys in the likely areas until within the past 3 years. The range of some rodents is more extensive than that recorded several years ago, and observations have been made by competent officials of migration by rats and ground squirrels over distances of five or more miles within relatively brief periods.

⁶ Corresponding to a longitude 25 miles east of the west boundary of Kansas.

Thus far, infected animals have not been discovered east of the 102d meridian W., though repeated surveys have been made of much of the intervening territory as far as the 100th meridian W., and to a farther extent, north of the Missouri River.

There are two probable factors in the perpetuation, and extension, of the disease: the persistence of the infection in fleas for several months, and thus through the winter, in nests and burrows of colonizing and hibernating rodents; and a continuance of the disease through the sporadic infection of those rodents which do not hibernate.

Thirty to forty percent of 200 fleas have survived for 4 months in the nests of ground squirrels which hibernated in the laboratory at a constant temperature of 40° F. The surviving fleas commenced active breeding promptly when removed from the nest and brought immediately to a temperature of 60° F. Under the same conditions, 10 to 12 percent of 200 infected fleas survived, but half of these died within a few days after removal from the nest. The infected fleas did not transmit the disease to hibernating squirrels, nor to other animals on which the survivors among them fed, subsequent to removal from the nest of the hibernating animal. It has been determined that an infected flea will transmit the disease 4 months after having become infected if it is maintained during the interval under favorable conditions, which include periodic feedings on a host. Furthermore, it has been found that one infectious flea will transmit the disease to each of several animals on which it feeds, though it may not infect all of them.

These observations indicate that though a large number of infected fleas may clear themselves or die during the winter, there are survivors. Some of these survivors may be infectious, and the most favorable opportunities for the infection of several animals by one or a few infectious fleas are afforded among the relatively dense populations of colonizing rodents, particularly when the density is greatest at the time of birth of the young.

It is very improbable that the disease is disseminated beyond the colony of hibernating animals during the winter, but infected rodents and fleas have been found repeatedly in the spring soon after the termination of hibernation, and with the emergence of the young from the burrows.

It has been reported that plague may be carried through the winter as a subacute or chronic infection of the hibernating animal, and that an acute recrudescence may occur in the animal with the change of its mode of life, or with pregnancy, upon the termination of hibernation in the spring. No evidence has been obtained during these surveys to support the opinion that a rodent carrier of subacute or chronic plague is a factor in the perpetuation of the enzootic. No

success has attended efforts to infect fleas on an animal which has not developed a bacteremia of marked degree, and it would appear, therefore, that the development of an acute recrudescence in the carrier of the quiescent disease would be necessary to the infection of the flea vectors. This premise is difficult to prove or to examine.⁷

Neither extensive nor systematic surveys have been conducted during the winter months, and plague has been found but rarely among nonhibernating field animals during this season. It has been found among them early in the spring, as well as at later periods, in locations which are relatively distant from colonies of hibernating animals. It has also been found among different genera of nonhibernating animals in the same location for as many as three successive seasons. Sharp epizootics which have devastated and apparently extinguished local populations of prairie dogs have been encountered, but infected nonhibernating rodents remained in the area. Infected rats, meadow mice and fleas have been collected during December on the Pacific slope of Washington. These several observations have led to the assumption that the nonhibernating animals serve to perpetuate the disease during the winter and to assist in its dissemination. The ranges of different genera of the nonhibernating rodents overlap, but as a group they extend across the continent, and species of fleas which infest some of them are capable vectors. There is no evidence at hand that the rodent species of the more eastern habitats are resistant to infection with plague, or that the fleas which are specific to them are not capable vectors. On the contrary, it is probable that these animals can furnish the means of spreading the disease among rodents and into human habitations which they enter, from the Pacific Ocean to the Atlantic.

The rapidity of extension eastward will probably be influenced by the density of the rodent populations and the persistence from year to year of foci in which acute outbreaks recur. The dense focal populations of the principal colonizing ground squirrels and prairie dogs do not extend much beyond the 97th meridian W.⁸ in significant numbers. Beyond this limit, any extension must occur in the noncolonizing rodents. However, among these, meadow mice (*Microtus*), pack rats (*Neotoma*), cotton rats (*Sigmodon*), rice rats (*Orizomys*), and Norway rats (*Rattus*) develop large, relatively dense, populations, occasionally or periodically.

The introduction of infectious fleas into such populations may be followed by an acute outbreak and an enzootic focus. There is,

⁷ One male squirrel which was inoculated with plague during its hibernation developed a small area of infection at the site of the inoculation. On emergence from hibernation, the animal remained well. When examined at autopsy, a pigmented scar was present at the site of inoculation. Another which was inoculated under similar circumstances died within 2 weeks with acute plague.

⁸ Corresponding to a longitude 75-100 miles west of the western boundary of Minnesota.

however, no assurance that such a series of events will occur, since there are some specific conditions known, and doubtless others unknown, which must be favorable to assure the production of the disease. Thus, the infection of a high percentage of fleas is accomplished consistently only by placing them on an animal within a few hours of its death from bacteremia, after having starved the fleas for a few days. Many fleas will not feed within less than 48 hours. A large number of those which feed on infected blood clear themselves of it without becoming infectious, others retain the infection for periods of weeks. In most instances, if not in all, an interval of from a few days to 3 or 4 weeks elapses after feeding the infected blood before the flea transmits the infection by biting, though it feeds on susceptible hosts in the interval. This interval varies with different species of fleas and is probably influenced also by the temperature of the surroundings of the flea in the burrow, nest, or runway.

It will be apparent that an element of chance enters into the fulfillment of conditions favorable to the progressive spread of the disease. Nevertheless, it has been disseminated over large areas of the United States which are relatively adjacent to one another, and the possibilities of its introduction into new and more remote areas through migrations and through the channels of commerce and transportation are deserving of continuous and expectant attention.

ULTRAVIOLET IRRADIATION IN THE PRODUCTION OF POTENT ANTIRABIES VACCINES¹

By KARL HABEL, *Surgeon, United States Public Health Service*

The use of ultraviolet irradiation as a means of inactivating rabies virus for the production of antigenic vaccines was first tried by Hodes, Webster, and Lavin (1). Subsequent publications of Webster and Casals (2, 3, 4, 5) developed the practicability of irradiated rabies vaccine in the prophylaxis of rabies in man and dogs. This work was done with virus inactivated by the irradiation from either low-pressure mercury vapor or resonance lamps, and the method of exposure of the virus was by means of a rotating quartz flask. More recently, Oppenheimer and Levinson (6) have developed a new type of mercury vapor lamp which emanates a relatively large percentage of its total energy output in wave lengths shorter than 2,000 angstrom units. Levinson et al. (7) reported on experiments with this type of lamp in the production of highly antigenic rabies vaccines. The

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method of exposure in their experiments involved a continuously flowing thin film of virus suspension.

The purpose of this study is to investigate further the properties of the Oppenheimer-Levinson type of lamp and exposure chamber insofar as rabies vaccine production is concerned, and to check the limitations of the method as well as of the vaccine so produced.

METHODS

Preparation of virus emulsions.—The brains of rabbits and mice infected with rabies were harvested at the time the animals showed complete prostration after an intracerebral inoculation of fixed rabies virus. The brains were emulsified in suspensions of various concentrations in buffered salt solution by the use of a Waring blender. Some emulsions were filtered through gauze or 200-mesh screen; others were used without filtration.

Ultraviolet irradiation.—The details of the lamp and exposure chamber set-up of the Oppenheimer-Levinson type have not as yet been released by the Committee on Medical Research of the Office of Scientific Research and Development.

Exposure to the lamp is made by use of a thin-walled quartz chamber whose inside measurements are approximately 1 cm. \times 12.5 cm. \times 0.2 mm. Material to be exposed flows in a continuous stream through this chamber, placed 1 cm. from the lamp. After passing the lamp the material is no longer exposed to the irradiation.

Virus emulsions were exposed for varying periods. That exposure which represented the shortest time necessary to completely inactivate all virus was used for potency testing.

The low-pressure lamp apparatus consisted of a bank of eight 15-watt germicidal lamps (8). Material to be exposed was placed in a quartz flask rotated slowly in the middle of the bank of lamps.

When comparative tests were run with the two types of lamps on the two methods of exposure, a single resonance lamp was used with the thin-film chamber, and the quartz flask was placed beside the Oppenheimer-Levinson lamp. When long exposures (over 2 seconds) were desired with the chamber-type of exposure, two chambers were connected in series, and the material passed the lamp two times.

Inactivation by chemical agents.—Whenever comparisons were being made between irradiated and chemically killed virus, the same original brain emulsion was divided into equal parts. Phenol and chloroform were used at a 1-percent concentration. The phenolization took place at 37° C., and chloroformization at 4° C. Samples were removed at various intervals, diluted to a 5-percent emulsion and stored while being tested for viability. That sample in which the virus was killed

by the shortest exposure to each chemical agent was the one used as a vaccine.

Demonstration of viability of virus.—All inactivated materials were checked for viable virus by intracerebral inoculation of five young Swiss mice. Samples were diluted to the equivalent of a 5-percent emulsion before the mice were inoculated. These animals were observed for 3 weeks.

Potency test of immunizing power of vaccines.—A mouse test previously described (9) was used for determining potencies of vaccines. All vaccines were diluted to the equivalent of a 0.5-percent emulsion, and six doses of 0.25 cc. each were given intraperitoneally every second day to Swiss mice (13–15 gm.). The intracerebral test dose of serial tenfold dilutions of fixed virus was given on the fourteenth day after the first dose of vaccine. The degree of protection is expressed as the number of LD₅₀ resisted by the immunized mice.

INACTIVATION OF VIRUS

Ultraviolet irradiation.—The Oppenheimer-Levinson lamp and chamber was used. Six runs were made in each of which at least five samples were removed following varying lengths of exposure. Each sample was tested for viability in mice. In table 1 it is seen that the exposure necessary to completely inactivate rabies virus was between 0.34 and 0.72 seconds, with brain emulsions at 5-, 10-, or 20-percent concentration. There appeared to be no demonstrable difference in the time necessary to kill in these three different concentrations.

TABLE 1.—*Exposure necessary to inactivate rabies virus emulsions by irradiation and chemical treatment*

Brain emulsion	Titer of original emulsion	Exposure necessary to inactivate		
		Ultraviolet	1-percent phenol	1-percent chloroform
20-percent mouse brain, whole emulsion...	10 ⁻⁴	0.34 second.....	Less than 10 hours...	21 days.
20-percent mouse brain, supernatant.....	10 ⁻⁴	0.41 second.....	Less than 4 hours...	21 days.
10-percent mouse brain, whole emulsion...	10 ⁻⁴	0.52 second.....	Less than 3 hours...	
10-percent mouse brain, whole emulsion...	10 ⁻⁴	0.72 second.....	6 hours.....	
5-percent mouse brain, whole emulsion...	10 ⁻⁴	1.7 seconds ¹	6 hours.....	
5-percent rabbit brain, whole emulsion...	10 ⁻⁴	0.36 second.....	12 hours.....	
5-percent rabbit brain, whole emulsion...	10 ⁻⁴	0.5 second.....	3 hours.....	
5-percent mouse brain, whole emulsion...	10 ⁻⁴	1.2 seconds ¹	6 hours.....	

¹ Given one fixed exposure.

Phenol inactivation.—One-percent phenol at 37° C. completely inactivated rabies virus in emulsions of 5, 10, and 20 percent after from 3 to 12 hours' exposure.

Chloroform inactivation.—One-percent chloroform at 4° C. required 21 days' exposure to kill virus in a 20-percent emulsion.

IMMUNIZING POTENCIES OF VACCINES

Comparison of irradiated with chemically inactivated vaccines.—In table 2 is shown a typical protocol of an immunity test in mice com-

TABLE 2.—*Typical potency test protocol: Ultraviolet-irradiated vaccine compared with phenolized vaccine*

Vaccine	Fixed virus test dose, dilutions inoculated intracerebrally							50-percent endpoint	MLD protection
	10 ⁻¹	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁷		
Irradiated.....	¹ 3/12	2/11	4/10	0/8	0/11			1/10	247,000
Phenolized.....	5/9	6/10	3/7	2/8	0/6			1/190	13,010
Controls.....					7/7	5/7	1/7	1/2,472,000	

¹ Number of mice with rabies over total mice in each group.

paring samples from a single brain emulsion which were completely inactivated by irradiation and by phenol. A summary of the results of eight such potency tests is given in table 3, in which are included six comparisons of irradiated and phenolized vaccines made from the same brain emulsions, and two comparisons between irradiated, phenolized, and chloroform-killed vaccines.

The degree of immunizing potency of the irradiated vaccines was invariably greater than that of the chemically inactivated vaccines from the same suspension.

TABLE 3.—*Summary of comparisons of potencies: Ultraviolet compared with chemically inactivated vaccines*

Experiment	Titer of original emulsion	Concentration of emulsion inactivated (percent)	MLD protection by mouse test		
			Ultraviolet	Phenol	Chloroform
Experiment No. 1.....	10 ⁻⁶	5	247,000	13,010	
Experiment No. 2.....	10 ⁻⁴	5	30,200+	8,628	
Experiment No. 3.....	10 ⁻³	20	339,500	176	70,241
Experiment No. 4.....	10 ⁻³	10	11,476	54	166
Experiment No. 5.....	10 ⁻⁴	10	38,045	25	
Experiment No. 6.....	10 ⁻⁶	10	96,830		
Experiment No. 7.....	10 ⁻³	5	9,611	334	
Experiment No. 8.....	10 ⁻³	20	5,585+		
Experiment No. 9.....	10 ⁻⁶	5	49,780+	35	
Experiment No. 10.....	10 ⁻³	20	67,700	9,580	

Effect of virus titer on potency of vaccines.—In table 3 there is shown a tendency of the immunizing potency of the irradiated vaccines to be directly related to the titer of virus in the original brain emulsion. This is also shown for the phenolized vaccines and has been pointed out in a previous publication (10). The difference, however, between the two methods of inactivation lies in the fact that even with the low titer emulsions, irradiation still gives a potent vaccine, whereas phenolization does not. In the case of experiment No. 4, the virus was in the form of supernatant only, not a whole brain emulsion. Yet after

the virus was killed by irradiation it still had a protection potency against over 11,000 LD₅₀ of virus, whereas phenolization and chloroformization of the same supernatant gave little immunizing potency (protection against 54 and 166 LD₅₀ of virus).

Potencies of vaccines irradiated at different concentrations of brain emulsions.—Just as the concentration of the brain emulsions seemed to make no difference in the irradiation exposure necessary to completely inactivate the virus, the immunizing potencies were equally high with the different concentrations of emulsions (see table 3).

Potency of irradiated vaccine against preimmunization street virus inoculated intramuscularly.—In a single experiment, 20 guinea pigs received 0.25 cc. of a 1/10 brain emulsion of third monkey-passage street virus in the gastrocnemius muscle. Ten of these animals were then given 0.1 cc. of irradiated vaccine No. 8 subcutaneously daily for 14 doses. One of the vaccinated guinea pigs died and was Negri positive, whereas 4 of the 10 controls died of rabies.

Potency of irradiated vaccine against preimmunization fixed virus inoculated intramuscularly.—A group of 245 mice was divided into 7 subgroups and given 0.03 cc. of from 1/4 to 1/256 dilutions of an intramuscular strain of rabies fixed virus into the gastrocnemius muscle. Beginning the same day and continuing daily for 14 days, the mice received 0.05 cc. of irradiated vaccine No. 3 subcutaneously. The 50-percent endpoint in the control mice was 1/256 and that in the vaccinated mice 1/202, showing no protection.

In mice the incubation period following this strain of fixed virus given intramuscularly is relatively short—about 7 days. This experiment, therefore, was repeated in guinea pigs, using a guinea pig-adapted intramuscular fixed virus. The gastrocnemius muscle of groups of five guinea pigs each (200–250 gm.) were inoculated with 1/10, 1/20, 1/40, 1/80, and 1/160 dilutions of fixed virus. The treated groups then received daily doses of 0.1 cc. of irradiated vaccine No. 8 subcutaneously for 14 days. The vaccinated animals survived 3 LD₅₀ of virus which by this method of testing represents a significant degree of protection.

Serum antibody response of guinea pigs following immunization with irradiated vaccine.—Twenty-five guinea pigs were bled 30 days after receiving 14 daily doses of irradiated vaccine No. 8 (0.1 cc., subcutaneously). The serum was tested by the complement-fixation, virus-neutralization, and virus-protection tests previously described (11). The serum titered 1/32 (3+ fixation) by complement fixation. By the virus-neutralization technique in mice 0.03 cc. of serum neutralized at least 10,000 LD₅₀ of virus. The mice were protected against 4 LD₅₀ of intramuscular virus in the virus-protection test.

Potency of irradiated vaccines as related to overexposure of virus.—In order to determine the safety factor in over-irradiating the virus beyond the point necessary just to inactivate, the experiments shown in table 4 were done. In experiment No. 2, the vaccine was irradiated about eight times as long as necessary just to kill the virus. This vaccine gave an immunizing protection against only 709 LD₅₀ of virus as compared to 30,200 LD₅₀ for the vaccine in which the virus was just inactivated. However, in experiments No. 3 and No. 4, exposures two and five times that necessary just to kill resulted in little change in the immunizing potencies of the vaccines.

TABLE 4.—Effect of over-irradiation of rabies vaccines on their potency

Experiment	Concentration of emulsion (percent)	Exposure	Potency ¹
Experiment No. 2.....	5	0.36 second ¹	30,200+
		2.7 seconds.....	709
Experiment No. 3.....	20	0.34 second ¹	339,500
		0.72 second.....	169,750
Experiment No. 4.....	10	0.52 second ¹	38,045
		2.5 seconds.....	48,285

¹ Exposure necessary just to inactivate virus.

² MLD protection by intracerebral mouse test.

Preservation and storage of irradiated vaccines.—Two experiments have been completed in which various preservatives were added to a suspension of rabies-infected brains already inactivated by ultraviolet irradiation. The results are shown in tables 5 and 6. Equivocal results were obtained in regard to the effect of storage at 4° C. on the vaccine alone without the addition of any preservative. In the first experiment the potency was completely destroyed after 6 months, whereas in the second test (table 6) the potency held up better than the samples to which preservatives had been added. However, the experiments were consistent to the extent that the process of lyophilizing the irradiated vaccine caused an initial drop, due to the procedure

TABLE 5.—Storage experiment with various preservatives added to ultraviolet-inactivated vaccine

Time of potency test	No preservative	No preservative, lyophilized	0.5-percent phenol	0.5-percent chloroform	0.25-percent tricresol	1/10,000 merthiolate	0.1-percent formalin
Protection at time of production.....	149,660	7,412					
Protection after 6 months' storage at 4° C.....	1	4,086	7,047	5,008	7,047	7,047	0

¹ LD₅₀ protection by intracerebral mouse test.

TABLE 6.—*Storage experiment with various preservatives added to ultraviolet-inactivated vaccine*

Time of potency test	No preservative, pH 7.0	No preservative, pH 7.0, lyophilized	No preservative, pH 7.6	0.5-per-cent phenol	0.5-per-cent chloroform	0.25-per-cent tricresol	1/10,000 merthiolate	0.1-per-cent formalin
At time of production.....	196,830	2,717						
After 6 months' storage at 4° C.....	10,543	8,194	54,544	7,566	87,861	538	3,938	2,227

¹ LD₅₀ protection by intracerebral mouse test.

itself; but once dried, the potency then held fairly well. Formalin in a concentration of 0.1 percent was definitely detrimental to preservation of potency, whereas 0.5-percent phenol, 0.5-percent chloroform, 0.25-percent tricresol, and 1/10,000 merthiolate seemed almost equivalent in preserving potency. Merely adjusting the pH to 7.6 in the one experiment seemed to enhance the ability of the vaccine to withstand storage. Levinson et al. (7) have found storage with merthiolate as a preservative to be satisfactory.

Comparative potency tests of vaccines made with different lamps and different methods of exposure.—There would appear to be two new principles involved in the irradiation technique developed by Levinson and Oppenheimer, namely, a lamp of high energy intensity which consists partially of light with a wave length less than 2,000 angstroms and, secondly, an exposure chamber giving maximum exposure to a continuously flowing, very thin film of material. The question arose as to which of these two deviations from the usual irradiation technique was responsible for the high potencies of the vaccines so prepared. An experiment was set up in which a single batch of brain emulsion was exposed by means of the thin-film chamber to the Levinson-Oppenheimer lamp and to a single low-pressure resonance lamp. The same emulsion was also exposed to each of these lamps by means of a rotating quartz flask, except that with the rotating flask a bank of eight low-pressure resonance lamps was used, the flask being placed in the center so as to receive irradiation from all directions. Samples of virus exposed for varying lengths of time were tested for viability by intracerebral inoculation of mice, and the samples just inactivated were then used for potency tests. In table 7, it is seen that high potencies are correlated with the use of the thin-film exposure chamber rather than with the type of lamp. Also it is obvious that in spite of a thousandfold differential in ultraviolet energy output of the two lamps, the differential in exposure time necessary to kill rabies virus was only about tenfold when the thin-film chamber was used.

TABLE 7.—*Comparison of potencies of irradiated rabies vaccines prepared by minimal-inactivating exposure to two types of lamps with two exposure techniques*

Type of exposure	Experiment No. 1		Experiment No. 2		Experiment No. 3	
	Time of in-activation	Po- tency ¹	Time of in-activation	Po- tency ¹	Time of in-activation	Po- tency ¹
High-pressure lamp, quartz chamber.	0.52 second..	38,045	0.72 second..	96,830	1.7 seconds..	9,611
Low-pressure lamp, quartz chamber.	2.1 seconds..	73,852	8.4 seconds..	23,560	5 seconds....	68,240
High-pressure lamp, quartz flask....	20 minutes..	2,151	20 minutes..	9,485	30 minutes..	0
Low-pressure lamp, quartz flask....	10 minutes..	25,110	30 minutes..	13,160	30 minutes..	3,159
Titer of original emulsion.....	1/55,340		1/3,163,000		1/421,700	

¹ LD₅₀ protection against intracerebral fixed virus in mice.

DISCUSSION

The results of these experiments confirm those of Levinson et al. that rabies vaccine irradiated by the Levinson-Oppenheimer technique is consistently more potent than phenolized vaccine made from the same original brain emulsion. The potencies of rabies vaccines so produced are substantially greater than those produced by other techniques of irradiation. Webster's irradiated vaccines usually had a potency of less than 10,000 MLD, and his method was not practical from the standpoint of large-scale manufacture of rabies vaccines. The continuous flow technique used in these experiments, however, is adaptable to commercial-scale production.

Potency of the irradiated vaccine can be demonstrated by the standard intracerebral test and against both street and fixed virus, given intramuscularly when vaccine is administered after the virus is introduced. Serum antibody response to the vaccine in guinea pigs is also of a high titer.

As pointed out previously by Levinson et al., the safety factor in overexposure of rabies vaccine by this method is rather large. Up to five times the amount of irradiation necessary to inactivate the virus apparently does not appreciably reduce the immunizing potency of the vaccine.

The vaccines produced by this method are free from the presence of any deleterious chemical agent left after the inactivation process and are relatively stable in the presence of proper preservatives. It is a practical method of preparing rabies vaccines for canine as well as for human use since emulsions as heavy as 20 percent are easily and quickly inactivated and retain high immunizing potency.

The fact that relatively low-titer emulsions and even cell-free supernatants have a satisfactory immunizing potency when attenuated by this irradiation technique offers promise of a purified rabies vaccine in which the potency is still high.

Tests comparing the Levinson-Oppenheimer lamp with a low-pressure resonance-type lamp indicate that the increased potencies of vaccines attenuated by this new irradiation technique depend not on the shorter wave lengths of the new type of lamp but upon the method of exposing the virus to either type of irradiation in the thin-film continuous-flow chamber devised and used by Levinson and Oppenheimer. This chamber gives inactivation with less exposure than with other types of exposure apparatus. The ultraviolet passes through a very thin layer of highly purified quartz before reaching the virus material. The film of virus suspension exposed is only 0.2 mm. thick, and because of the continuous flow no part of the virus is reexposed past the point of inactivation. These, then, seem to be the important factors in accomplishing inactivation of rabies virus by ultraviolet irradiation with preservation of high antigenicity in the production of rabies vaccines.

SUMMARY

(1) Highly potent rabies vaccines were prepared by use of the Levinson-Oppenheimer ultraviolet technique and apparatus in the irradiation of rabies brain suspension.

(2) Irradiated vaccines were consistently more potent than comparable phenolized vaccines.

(3) Whole-brain emulsions as heavy as 20 percent were inactivated by this method of irradiation.

(4) The potency of the irradiated vaccines was satisfactorily preserved in storage at 4° C.

(5) The important factor in this technique of irradiation apparently was the use of the thin-film chamber as a means of exposing materials.

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PRELIMINARY STUDIES ON THE CONTROL OF BLOWFLIES WITH DDT¹

By W. C. BAKER, *Senior Assistant Sanitarian (R)*, and L. G. SCHWARTZ, *Junior Biologist, United States Public Health Service*

Preliminary studies on the use of DDT in the control of several species of blowflies (*Calliphoridae*) were made to gain information on methods of application, the effectiveness of the spray material, and the duration of effective control.

The tests were made in a varied group of establishments that included a retail fish market, an abattoir, a seafood plant, and a hide-processing plant. Of the several species of flies found present, those of the genera *Cochliomyia* and *Lucilia* were most common.

The habits of the blowfly vary greatly from those of the housefly, and alterations of the techniques of spray application are necessary. Some of the habits of blowflies to be considered in the effective use of DDT sprays are: The use of scattered night resting places, such as on the sides of buildings, under eaves, in open sheds, under miscellaneous trash materials, and especially on the upper portions of such vegetation as weeds, bushes, and small trees near the daytime feeding places of the blowflies; a preference for putrefying food material, such as offal, fish, blood, and decaying fruits and vegetables; the ability to fly for great distances; the tendency to alight only on food and to fly from one piece to another without resting to any appreciable extent on the flooring, walls, and ceiling; and the infrequency with which blowflies enter buildings.

In all operations a 5-percent-DDT emulsion was used. It was made by adding 6 gallons of water to 1 gallon of a stock solution containing 35-percent DDT (w/v) dissolved in xylene, with 4 percent of the emulsifier Triton X-100².

¹ From Communicable Disease Center, Technical Development Division (Savannah, Ga.), States Relations Division.

² An alkyl-polyether alcohol manufactured by Rohm & Haas Co., Philadelphia, Pa.

In estimating the pretreatment and posttreatment fly-population indices, the grill-device method of sampling was used³. This method consisted of placing a 3-foot-square grill work, consisting of alternate $\frac{3}{4}$ -inch slats and open spaces, on any surface attracting a concentration of flies. After the flies had been aroused and had resettled, the number of flies resting on the grill was counted. Five such counts were made at the points of maximum concentration in each of several areas. From each location, the maximum count was taken, and from these maxima, a definite number (approximately three-fourths) of the highest counts were averaged to give an index figure of maximum fly nuisance.

The use of the grill device is not so satisfactory for sampling a blowfly population as it is for sampling houseflies, since blowflies do not remain on the grill as long as houseflies. Soon after alighting, they tend to pass through the open spaces of the grill and go to the attractant beneath it. This is especially true when large numbers are present, and competition for an undisturbed resting or feeding place is indicated. Consequently, with heavy concentrations, one has time to count only the most representative quadrant of the grill, and to use the number thereon as one-fourth its entire capacity.

Even with this disadvantage, this method was still superior to any other sampling method tried. Its advantages over the well-established bait trap, sweep net, and other methods are that it does not attract flies but samples those already present; it does not drive the flies away by violently disturbing them; it is mobile and permits the sampling of a population wherever the maximum concentrations occur; it does not depend upon a competitive attractant; it is a time saver in that samples can be taken very rapidly; and it is easily and cheaply constructed.

In all inspections only the blowflies were counted. Other flies, such as the housefly and the stablefly, were not included in the grill counts.

PROCEDURE AND RESULTS

The initial work on blowflies was done at a fish market and at an abattoir. In the former the principal focal point for blowflies was a loading platform used for the uncrating and washing of fish. Twice daily the platform was washed off, but much of the scrap fell through openings in the wooden planking. This resulted in an accumulation beneath the low platform, which attracted flies and made possible their breeding on the premises. The garbage containers were kept at one end of the platform, but they were not always covered or

³ Scudder, H. I. A new technique for sampling the density of housefly populations. Pub. Health Rep., 62: 681-686 (May 9, 1947).

emptied regularly. Next door to the fish market was a large open-air vegetable stand.

On August 21, 1945, the walls and the ceiling over the platform were treated at the customary rate of 200 mg. of DDT per square foot, and the wooden platform and cement apron fronting it were treated at the rate of 300 mg. per square foot. The purpose of this higher dosage was to maintain a DDT residue for a longer period of time on the platform and apron, which were washed daily.

Treatment was made with a nozzle, producing a fan-shaped spray pattern with an 80° dispersion angle and having a discharge rate of 0.4 gallon per minute at 40 pounds, pressure.

Pretreatment and posttreatment population indices were determined at weekly intervals. In the inspections over an eight-week pretreatment period, the blowfly indices ranged from 32 to 115 flies. In the first 2 weeks subsequent to treatment satisfactory control was obtained. In the third week the population index approached the lower limits of the pretreatment indices. In the fourth and fifth weeks the index was well within the limits of the pretreatment indices (table 1).

Six weeks after the initial treatment the platform and cement apron were again sprayed at the rate of 300 mg. per square foot.

During the first 3 weeks after the supplemental treatment the fly control was again satisfactory. Four weeks after treatment the population level approached the lower limits of the pretreatment indices, and in the sixth week the index was above that of the pretreatment average. It is believed that, had a hedge and some bushes on the adjoining property to the rear of the platform been treated, more satisfactory results and a longer period of effective control would have been obtained.

In studies at an abattoir it was observed that large numbers of calliphorids were attracted to an open waste tank, where infrequent removal of material permitted breeding to such an extent that a layer

TABLE 1.—*The effect of a DDT residual treatment on the population indices of calliphorids when applied to a fish-market loading platform and its environs at the rate of 200 and 300 mg. per square foot*

Item	Pretreatment period						Treated August 26, 1945	Posttreatment period					Treated October 1, 1945	Post-supplemental-treatment period				
	June		July		August			Aug.		September				October				Nov.
Inspection date...	30	12	20	25	9	13	28	6	12	20	25	2	9	25	31	13		
Number of weeks before and after treatment.....	8	6	5	4	2	1	1	2	3	4	5	0	1	3	4	6		
Weekly fly index.	43	115	58	48	32	60	12	5	25	34	46	6	1	3	26	88		



FIGURE 1.—A seafood plant with collections of shrimp, crab, and oyster wastes, constituting a blowfly attractant and breeding place. The tree in the foreground made an ideal night resting place for blowflies.



FIGURE 2.—An abattoir with collections of hair and intestinal wastes in which dense breeding of blowflies occurred.

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of mature maggots, three-fourths of an inch deep, was commonly observed on the surface. From a second-story platform above the tank there was considerable spillage of waste materials to a cement apron below. Periodically this material was hosed off the cement apron onto an earthen bank, where it constituted a suitable medium for further breeding.

To exercise some control over the number of flies present, an application of the 5-percent-DDT emulsion was made at the rate of approximately 200 mg. per square foot to the tank, the walls of the building about the tank, the cement apron, and the partially open rendering room adjoining the tank. Also sprayed were the walls and ceiling over a loading platform that was located about 250 feet from the tank. Numerous blowflies were often observed on this platform feeding on blood-stained wrapping paper that was carelessly piled in any convenient location.

Prior to treatment early-season inspections revealed indices of 17 to 96.5 blowflies. One week after treatment the adult emergence was still so great that the blowfly index remained above 15, a number arbitrarily established as a maximum for satisfactory control. In the second week following treatment, and thereafter for 7 weeks, effective control of the flies was maintained. During the inspection trips of the eighth and ninth weeks after treatment, sanitation at the plant was observed to be very poor. Inspections on the ninth and tenth weeks showed a substantial increase in the number of flies present, but a few weeks after normal sanitary practices were resumed, the fly population receded to a point at which it approximated the early post-treatment level.

Three months after treatment a fire destroyed a considerable portion of the plant, including several of the refrigeration units, so that much of the stored meat was spoiled and had to be removed for rendering. During the month that followed, routine sanitary operations were not performed and there was a great increase in the number of flies.

A second treatment was made on October 24 (4 weeks after the fire), at the rate of approximately 300 mg. DDT per square foot of surface, and the DDT was applied with a power sprayer at 200 pounds' pressure. The waste tank, cement apron, the grasses for about 25 feet from the banking at the edge of the cement apron, the rendering room, and the nearby work shop were sprayed.

One week after treatment there was a substantial reduction in the number of flies, but the population was considered to be still above a satisfactory level of control. During the third and fourth weeks the population level was satisfactory in spite of the poor sanitation that still prevailed. After this time the cool autumn nights began to slow

TABLE 2.—Pretreatment and posttreatment weekly blowfly indices determined by the grill method at an abattoir treated with a 5-percent-DDT emulsion at the rate of 800 and 300 mg. of DDT per square foot of surface treated

Item	Pretreatment period						First posttreatment period												Period after fire				Second post-treatment period	
	May			June			July			August			September			September		October		October	November			
	10	17	25	7	13	21	7	12	27	2	9	21	24	1	8	14	29	7	23	29	6	13		
Inspection date.....																								
Number of weeks before and after treatment.....	7	6	5	3	2	1	1	2	4	5	6	7	8	9	10	11	7.5	1	2	4	1	2	3	
Weekly index.....	28.7	29.5	31.5	96.5	88.2	17.0	26.8	3.5	4.3	8.8	6.3	2.0	2.0	54.0	180.0	3.7	7.5	100.0	238.0	38.0	7.5	7.5		
Period index.....	48.6						12.9						115.2						17.7		17.7			
							Sprayed June 28						Fire Sept. 21						Sprayed Oct. 24					

up fly activities, and further data on effectiveness could not be accurately determined. (See table 2.)

In the latter part of the season inspections were made at a hide-processing plant that served several of the neighboring counties, processing green hides and rendering fats and condemned meats. On the premises large numbers of adult calliphorids were found frequenting the green hides and renderable waste products. Under the hides in the main building, in the stored rendered products, and in the soil into which hide scraps and putrefying juices had been penetrating over a period of time, considerable numbers of fly larvae were found developing. A little over one-fourth mile away, a distance which is within easy flight range for most calliphorids, there was a large untreated abattoir where a very high population of calliphorids was always present.

Because of the lateness of the season both pretreatment and post-treatment inspections were made semiweekly. Prior to treatment a night inspection of the premises was made to determine the resting locations of the blowflies, so that more effective application of the spray material could be made. It was found that the night resting places included a wide range of locations. In the main processing building that was closed before dark the flies were found on the side walls, boxes, beams, wires, etc., but generally not on the hides that they frequented during the day. Because of the height of the ceiling, the number of flies resting thereon could not be observed. In the outbuildings they were found scattered on the ceilings, wires, inner and outer walls, and under the eaves. The greatest concentrations of resting blowflies were found on the upper parts of grasses and shrubbery and in small trees near their daytime feeding places.

On October 18 the above locations were treated with a 5-percent-DDT emulsion. An orchard-type spray gun was used to reach the ceilings and to spray the grasses around the plant. The exact rate of application could not be determined because of the waste of spray material involved in such an operation, but it was approximately 300 mg. of DDT per square foot of surface treated.

Prior to treatment the semiweekly fly indices varied between 167 and 207 blowflies. Subsequent to treatment a great reduction was in evidence, and inspections gave indices of 1.5 to 3.3 flies (table 3).

Posttreatment inspections throughout the day showed that prior to the delivery of green hides, between midmorning and noon, there were no flies on the premises. At midday, after the delivery of the green hides, a few flies were present. Apparently these flies were transmitted along with the delivery of the green hides, as considerable numbers of flies were observed on the trucks as they pulled up to the weighing scales. By late afternoon additional flies were present,

TABLE 3.—*Pretreatment and posttreatment blowfly indices at a hide-processing and fat-rendering plant treated with a 5-percent-DDT emulsion at the rate of 300 mg. of DDT per square foot of surface treated*

Item	Pretreatment period					Sprayed Oct. 18	Posttreatment period						
	October						October				November		
	7	9	11	12	17		19	24	25	29	1	9	14
Inspection date.....													
Weekly inspection index.....	167.0	209.0	188.0	170.0	194.0		32.0	3.5	1.5	4.5	12.5	33.0	13.0
Period index.....			185.6							14.3			

apparently having migrated from neighboring sources. This post-treatment pattern, entirely different from the pretreatment all-day high levels, was constant during the period of observation.

The duration of effectiveness could not be estimated at this establishment due to the onset of the cool nights of autumn and the subsequent seasonal drop in fly populations.

In seafood plants most operational activities take place between autumn and spring, with only a minimum of activities being performed during the hot summer months. Consequently, the fly problems at such plants occur in the spring and autumn months. During these periods the large amount of waste products, primarily from shelling crabs and oysters, provides conditions conducive to a rapid increase in blowfly populations.

In one seafood plant work was commenced during the latter part of September. Two weekly inspections during the first part of October gave blowfly indices of 207 and 200 flies, respectively. Prior to treatment, early morning and night observations indicated that a very large proportion of the blowflies rested at night in the small trees and shrubbery near the oyster house, much the same as had been the case at the hide and rendering plant. On October 19 the trees and shrubbery, upper and under sides of the wharf, the crab shells around the wharf, the ceiling of the shelter protecting the crab-boiling pots, and the grasses for a distance of about 25 feet around the oyster house were treated with a 5-percent-DDT emulsion. The spray material was applied at a rate of approximately 300 mg. DDT per square foot of surface treated with an orchard-type spray gun at 200 pounds' pressure.

In the monthly interval between treatment and the advent of cool nights, satisfactory control of blowflies was obtained, as shown by the midafternoon indices in table 4. In the mornings of the first few days following treatment many dead flies were found, especially under the small trees and on the floor of the shelter containing the crab-boiling pots. Throughout the day there was the usual characteristic influx of calliphorid flies from adjacent areas.

TABLE 4.—*Pretreatment and posttreatment indices of blowflies at a seafood plant sprayed with a 5-percent DDT emulsion applied at the rate of approximately 300 mg. per square foot.*

Item	Pretreatment period		October 19 Sprayed.	Posttreatment period				
	October			October			November	
	2	10		24	26	29	7	14
Inspection date.....								
Weekly fly index.....	207.5	200.5		23.0	22.0	25.5	13.0	33.0
Period fly index.....	204.0			23.2				

SUMMARY

Preliminary tests were made with DDT for the control of blowflies at a fish market, an abattoir, a hide-processing plant, and a seafood plant, using a 5-percent DDT-xylene-Triton X-100 emulsion applied at a rate of 200 and 300 mg. DDT per square foot. The variation in the degree of control achieved was dependent to a large extent on the relationship between the night resting places of the flies and the extent to which such places were treated. At establishments where only the area about the daytime feeding places of the blowflies was treated, control was obtained for a 2- to 3-week period. At establishments where the night resting places were treated in addition to the area around the daytime feeding places, effective control of the blowflies was obtained for periods up to 3 months.

SMALLPOX IMMUNIZATION REQUIREMENT FOR AIR TRAVELERS TO JAMAICA

Information has been received that as of May 8, 1947, the following requirement is applicable to persons arriving at Jamaica by aircraft from New York.

"Persons who in the opinion of the sanitary authorities are not sufficiently immunized against smallpox will be subject to vaccination on arrival, followed by surveillance for a period which will not exceed fourteen (14) days from the date of arrival of the aircraft."

Notification has also been received that Jamaica will apply a similar requirement to persons arriving from other ports in the United States, including Puerto Rico, immediately upon receipt of information that smallpox exists in those localities.

A NEW *SALMONELLA* TYPE ISOLATED FROM MAN: *SALMONELLA TEXAS*¹

By JAMES WATT, *Surgeon*, and THELMA M. DECAPITO, *Assistant Bacteriologist, United States Public Health Service*, and ALICE B. MORAN, *Kentucky Agricultural Experiment Station*.

An investigation of the prevalence of various intestinal pathogens is now being conducted in Hidalgo County, Tex. In the course of this work, rectal swab fecal cultures are obtained from a selected group of individuals each month. The specimens are taken in the home and plated directly on SS agar, and the swab is then placed in tetrathionate broth. These cultures are then examined in the laboratory for members of the *Shigella* and *Salmonella* group. In August 1946, the organism described below as *Salmonella texas* was isolated from one of our routinely studied patients.

The patient was a 4-year-old Spanish-American male. He was not sick at the time the culture was taken, but his mother stated that he had been ill with a moderately severe diarrhea from which he had recovered approximately 1 week before the examination was made. The illness lasted less than 1 week. The patient had 10 to 12 bowel movements daily during the acute phase; abdominal pain and anorexia were moderate, and no other symptoms were noted.

The organism isolated was not found on the original SS agar plate but was present in large numbers in the tetrathionate enrichment broth studied the following day. Three cultures, one each in September, October, and November, were obtained from the patient and all were negative for intestinal pathogens. No other members of the family reported any illness, and cultures taken on two of them during this period were negative.

IDENTIFICATION

The organism was a motile rod which possessed the usual cultural and biochemical attributes of the *Salmonella* group, except that it liquefied gelatin in 24 to 48 hours at room temperature. Glucose, arabinose, maltose, xylose, rhamnose, trehalose, mannitol, sorbitol, dulcitol, and inositol were fermented within 24 hours, and acid was produced from cellobiose after 5 days' incubation; lactose, sucrose, raffinose and salicin were not attacked. D-tartrate, l-tartrate, citrate, and mucate were fermented, but l-tartrate was not utilized. Hydrogen sulfide was produced, but indol was not formed.

Serologic examination revealed that the organism was a member of group B of the Kauffmann-White classification. It was agglutinated by serum for factor V but not by serum for factor XXVII. In absorp-

¹ From the Division of Infectious Diseases, National Institute of Health, Pharr, Tex.; and the Department of Animal Pathology, Kentucky Agricultural Experiment Station, Lexington, Ky.

tion tests it left a slight residue of agglutinins in *Salmonella typhimurium* O serum. The somatic antigens of the culture are IV, V, XII.

The organism was diphasic. Phase 1 was agglutinated to the titer of serum derived from phase 1 of *Salmonella thompson* (k) but failed to remove all agglutinins from the serum. After absorption there remained a residue which amounted to 5 percent of the original titer. Phase 2 was agglutinated to the titer of *Salmonella glostrup* phase 2 serum, (e,n,z₁₅ . . .) and reacted with absorbed serums for factors z₁₅ and z₁₇. In absorption tests the organism again failed to remove all agglutinins from the test serum. The diagnostic formula of *S. texas* is IV, V, XII: k-e,n,z₁₅ . . .

SUMMARY

A new *Salmonella* type, *Salmonella texas*, was isolated from the feces of a child who had recovered from an attack of diarrhea 1 week before the examination was made. The diagnostic formula of the organism was IV, V, XII: k-e,n,z₁₅ . . . The culture liquefied gelatin.

SMALLPOX IMMUNIZATION REQUIREMENT OF COSTA RICA

According to a telegram dated April 28, 1947, Costa Rica has established a special smallpox immunization requirement. No person is permitted to enter or leave Costa Rica without a certificate of successful smallpox vaccination.

DEATHS DURING WEEK ENDED APR. 26, 1947

[From the Weekly Mortality Index, issued by the National Office of Vital Statistics]

	Week ended Apr. 26, 1947	Correspond- ing week, 1946
Data for 93 large cities of the United States:		
Total deaths.....	9,434	9,448
Median for 3 prior years.....	9,322	
Total deaths, first 17 weeks of year.....	170,947	169,248
Deaths under 1 year of age.....	733	631
Median for 3 prior years.....	609	
Deaths under 1 year of age, first 17 weeks of year.....	13,548	10,341
Data from industrial insurance companies:		
Policies in force.....	67,304,515	67,208,187
Number of death claims.....	14,063	12,527
Death claims per 1,000 policies in force, annual rate.....	10.9	9.7
Death claims per 1,000 policies, first 17 weeks of year, annual rate.....	10.0	10.9

DEATHS DURING WEEK ENDED MAY 3, 1947

[From the Weekly Mortality Index, issued by the National Office of Vital Statistics]

	Week ended May 3, 1947	Correspond- ing week, 1946
Data for 93 large cities of the United States:		
Total deaths.....	8,977	8,974
Median for 3 prior years.....	8,922	
Total deaths, first 18 weeks of year.....	179,924	178,222
Deaths under 1 year of age.....	747	645
Median for 3 prior years.....	621	
Deaths under 1 year of age, first 18 weeks of year.....	14,295	10,986
Data from industrial insurance companies:		
Policies in force.....	67,286,612	67,214,474
Number of death claims.....	13,724	12,466
Death claims per 1,000 policies in force, annual rate.....	10.6	9.7
Death claims per 1,000 policies, first 18 weeks of year, annual rate.....	10.0	10.9

INCIDENCE OF DISEASE

No health department, State, or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring

UNITED STATES

REPORTS FROM STATES FOR WEEK ENDED MAY 10, 1947

Summary

Of the total of 34 cases of poliomyelitis reported for the week, as compared with 25 last week, 56 for the corresponding week last year, and 32 for the 5-year (1942-46) median, 12 occurred in California (last week 5) and 3 each in Missouri and Texas. No other State reported more than 2 cases. A total of 855 cases has been reported to date this year, as compared with 729 last year and a 5-year (1942-46) median of 483 for the corresponding period. Since March 15 (the approximate average date of seasonal low incidence), 228 cases have been reported this year, as compared with 263 last year and a 5-year median of 181 for the same period. States reporting the largest numbers of cases since March 15 this year are as follows (corresponding last year's figures in parentheses): California 68 (32), New York 25 (31), Florida 12 (49), Texas 16 (35), Illinois 10 (8), Louisiana 10 (7), Michigan 8 (2), North Dakota 8 (1), and Missouri 7 (3).

A total of 2,298 cases of influenza was reported for the current week, as compared with 3,586 last week and a 5-year median of 1,072. The total for the year to date is 292,674 cases, of which 252,083 have been reported since March 1. For the corresponding periods last year the figures, respectively, are 183,596 and 23,246, and for the same periods of 1944 they were 330,757 and 24,243.

Slight net increases in the incidence of whooping cough were reported in all of the 9 geographic divisions of the country except the New England, South Atlantic and East South Central. The total of 3,914 cases reported for the week (last week 3,609, corresponding week last year 1,965, and 5-year median 2,576) is more than reported for any corresponding week since 1943 (4,133). The cumulative total for the year to date is 51,914, as compared with 35,000 for the same period last year, a 5-year median of 47,302, and 76,786 in 1943, the latter figure being the largest for a corresponding period of the past 5 years.

For the current week, 9,187 deaths were recorded in 93 large cities of the United States, as compared with 8,977 last week, 9,144 and 9,147, respectively, for the corresponding weeks of 1946 and 1945, and a 3-year (1944-46) median of 9,144. The total for the year to date is 189,111, as compared with 187,366 for the corresponding period last year.

Telegraphic morbidity reports from State health officers for the week ended May 10, 1947, and comparison with corresponding week of 1946 and 5-year median

In these tables a zero indicates a definite report, while leaders imply that, although none was reported, cases may have occurred.

Division and State	Diphtheria			Influenza			Measles			Meningitis, meningococcus		
	Week ended—		Med- ian 1942- 46	Week ended—		Med- ian 1942- 46	Week ended—		Med- ian 1942- 46	Week ended—		Med- ian 1942- 46
	May 10, 1947	May 11, 1946		May 10, 1947	May 11, 1946		May 10, 1947	May 11, 1946		May 10, 1947	May 11, 1946	
NEW ENGLAND												
Maine.....	1	4	0		1		102	143	127	1	1	1
New Hampshire.....	0	0	0				12	42	38	0	0	0
Vermont.....	0	1	1	7	2		172	39	66	0	0	0
Massachusetts.....	13	8	4				402	2,683	1,280	1	1	6
Rhode Island.....	1	1	1			1	173	35	52	0	1	1
Connecticut.....	1	2	0	8	1	1	1,072	411	411	3	2	3
MIDDLE ATLANTIC												
New York.....	16	18	15	11	15	15	636	4,265	1,555	5	13	24
New Jersey.....	8	11	4	2	4	4	461	4,170	1,192	1	5	6
Pennsylvania.....	16	13	10	(7)	11	11	284	3,414	1,329	4	12	12
EAST NORTH CENTRAL												
Ohio.....	12	17	10	2	3	5	918	999	497	2	5	12
Indiana.....	3	6	6	2	1	1	155	493	219	5	3	4
Illinois.....	4	8	8	4	9	11	228	792	695	4	7	14
Michigan ¹	10	5	3	2			116	1,027	902	1	5	5
Wisconsin.....	2	0	1	10	14	22	365	2,968	2,320	2	3	3
WEST NORTH CENTRAL												
Minnesota.....	3	7	3				555	43	379	1	1	2
Iowa.....	0	2	2	70		1	1,248	156	183	2	3	1
Missouri.....	5	1	4	5	1	1	70	126	226	3	3	7
North Dakota.....	3	2	1	21	2	2	85	16	17	0	0	1
South Dakota.....	0	5	1				128	39	39	2	0	0
Nebraska.....	1	0	1			4	20	344	173	0	0	0
Kansas.....	4	6	4	1			17	320	465	0	0	1
SOUTH ATLANTIC												
Delaware.....	1	0	0				2	22	13	0	0	0
Maryland ²	6	8	6	10	4	4	41	682	423	3	3	5
District of Columbia.....	0	2	0		1	1	8	338	123	2	5	3
Virginia.....	3	8	3	471	102	102	272	763	326	0	9	9
West Virginia.....	2	1	2	15		8	48	302	159	1	1	1
North Carolina.....	8	8	6			4	155	537	537	1	0	2
South Carolina.....	3	4	4	384	205	163	130	439	127	1	0	1
Georgia.....	2	1	2	11	2	10	166	141	141	0	0	1
Florida.....	3	3	3	30		1	54	201	201	2	1	2
EAST SOUTH CENTRAL												
Kentucky.....	3	11	3	3			20	157	113	1	4	4
Tennessee.....	1	0	1	48	12	27	37	279	154	4	2	9
Alabama.....	3	2	4	220	11	24	223	228	205	1	1	5
Mississippi ³	3	7	7	9			13			1	3	3
WEST SOUTH CENTRAL												
Arkansas.....	4	3	2	39	29	23	91	123	123	1	1	2
Louisiana.....	2	0	4	22	7	2	23	190	88	1	0	2
Oklahoma.....	1	3	3	78	8	28	8	254	153	3	0	0
Texas.....	12	25	24	600	385	385	386	1,694	991	2	6	10
MOUNTAIN												
Montana.....	2	0	2	6	5	5	99	85	118	0	0	0
Idaho.....	0	1	0	3	3		2	141	80	1	1	1
Wyoming.....	1	0	0	1		1	14	38	93	0	0	0
Colorado.....	8	18	7	27	10	12	104	1,684	260	0	0	2
New Mexico.....	0	0	0	1		1	19	67	27	1	0	0
Arizona.....	2	2	2	131	14	25	45	150	118	0	0	0
Utah ⁴	2	0	0	6		3	7	343	283	0	0	0
Nevada.....	0	0	0				15			0	0	0
PACIFIC												
Washington.....	2	4	4	3			23	527	527	2	2	4
Oregon.....	3	1	0	18	4	8		330	185	0	2	2
California.....	11	16	16	27	10	24	270	2,968	2,968	10	9	17
Total.....	191	245	187	2,298	856	1,072	9,495	35,206	25,813	75	115	178
19 weeks.....	5,012	6,670	5,255	292,674	183,596	73,372	116,715	454,358	368,642	1,671	3,286	4,345
Seasonal low week ⁴	(27th)	July 5-11		(30th)	July 26-Aug. 1		(35th)	Aug. 30-Sept. 5		(37th)	Sept. 13-19	
Total since low.....	12,578	18,314	13,996	325,649	545,844	109,234	139,602	480,462	406,655	2,643	4,790	6,797

¹ New York City only.

² Period ended earlier than Saturday.

³ Philadelphia only.

⁴ Dates between which the approximate low week ends. The specific date will vary from year to year

Telegraphic morbidity reports from State health officers for the week ended May 10, 1947, and comparison with corresponding week of 1946 and 5-year median.—Con.

Division and State	Poliomyelitis			Scarlet fever			Smallpox			Typhoid and paratyphoid fever		
	Week ended—		Median 1942-46	Week ended—		Median 1942-46	Week ended—		Median 1942-46	Week ended—		Median 1942-46
	May 10, 1947	May 11, 1946		May 10, 1947	May 11, 1946		May 10, 1947	May 11, 1946		May 10, 1947	May 11, 1946	
NEW ENGLAND												
Maine.....	0	0	0	3	14	14	0	0	0	0	1	1
New Hampshire.....	0	0	0	4	4	5	0	0	0	1	0	0
Vermont.....	0	0	0	9	12	12	0	0	0	2	0	0
Massachusetts.....	0	0	0	109	187	345	0	0	0	7	0	1
Rhode Island.....	0	0	0	9	20	17	0	0	0	0	0	0
Connecticut.....	0	0	0	34	69	69	0	0	0	0	0	0
MIDDLE ATLANTIC												
New York.....	1	4	3	264	594	604	0	0	0	3	0	3
New Jersey.....	1	0	0	97	179	158	0	0	0	1	0	1
Pennsylvania.....	0	1	0	210	380	406	0	0	0	1	2	3
EAST NORTH CENTRAL												
Ohio.....	0	0	1	195	382	312	0	1	1	3	1	2
Indiana.....	1	0	0	116	56	66	1	0	0	1	2	2
Illinois.....	0	1	1	87	186	202	0	0	0	1	0	2
Michigan ¹	0	0	0	131	152	188	0	0	0	2	1	1
Wisconsin.....	0	1	1	65	122	221	1	0	0	0	0	0
WEST NORTH CENTRAL												
Minnesota.....	2	0	0	52	60	60	0	0	0	0	0	0
Iowa.....	1	3	0	24	46	46	0	0	0	1	4	0
Missouri.....	3	1	0	41	33	62	2	0	0	0	4	2
North Dakota.....	1	1	0	4	5	5	0	0	0	0	0	0
South Dakota.....	0	0	0	4	11	11	0	0	0	0	0	0
Nebraska.....	1	0	0	27	12	26	0	0	0	0	0	0
Kansas.....	1	1	0	46	35	63	0	0	0	0	0	2
SOUTH ATLANTIC												
Delaware.....	0	0	0	13	4	7	0	0	0	0	0	0
Maryland ²	0	0	0	30	200	180	0	0	0	1	0	0
District of Columbia.....	0	0	0	9	14	18	0	0	0	0	1	0
Virginia.....	0	0	0	28	72	66	0	0	0	4	0	1
West Virginia.....	0	0	0	12	35	35	0	0	0	1	2	1
North Carolina.....	0	0	0	20	27	27	0	0	0	2	0	1
South Carolina.....	0	1	1	3	5	5	1	0	0	3	2	2
Georgia.....	0	0	0	0	2	15	0	0	0	2	6	5
Florida.....	0	17	2	4	3	4	0	0	0	2	3	1
EAST SOUTH CENTRAL												
Kentucky.....	1	1	1	25	14	44	0	0	0	2	0	1
Tennessee.....	1	0	0	9	12	28	0	0	0	1	2	2
Alabama.....	0	2	1	9	19	8	0	0	0	1	3	1
Mississippi ³	0	0	2	3	5	5	0	0	0	0	1	1
WEST SOUTH CENTRAL												
Arkansas.....	0	1	1	2	10	10	0	0	0	4	2	2
Louisiana.....	2	1	0	2	7	7	0	0	0	3	2	5
Oklahoma.....	1	0	0	2	10	15	0	0	0	0	0	1
Texas.....	3	16	2	25	47	58	0	2	1	7	11	11
MOUNTAIN												
Montana.....	0	0	0	3	4	16	0	0	0	1	0	0
Idaho.....	0	0	0	3	9	10	0	0	0	1	0	0
Wyoming.....	0	0	0	0	8	16	0	0	0	0	1	0
Colorado.....	0	2	0	32	55	56	0	1	0	1	2	1
New Mexico.....	0	0	0	11	4	10	2	0	0	0	3	1
Arizona.....	2	0	0	6	10	10	0	0	0	0	0	0
Utah ⁴	0	0	0	7	21	21	0	0	0	0	0	0
Nevada.....	0	0	0	0	0	0	0	0	0	0	0	0
PACIFIC												
Washington.....	0	0	0	22	18	31	0	0	0	1	0	0
Oregon.....	0	0	0	10	42	36	0	0	0	4	1	0
California.....	12	2	2	136	142	166	0	0	0	5	2	3
Total.....	34	56	32	1,957	3,358	3,963	7	4	11	69	59	65
19 weeks.....	* 855	729	483	48,964	66,503	75,724	118	195	224	889	956	1,114
Seasonal low week ⁴	(11th) Mar. 15-21			(32nd) Aug. 9-15			(35th) Aug. 30-Sept. 5			(11th) Mar. 15-21		
Total since low.....	* 228	263	181	75,650	105,074	114,045	172	271	341	404	481	496

¹ Period ended earlier than Saturday.

² Dates between which the approximate low week ends. The specific date will vary from year to year.

³ Including paratyphoid fever reported separately, as follows: Massachusetts 7 (salmonella infection); Ohio 1; Michigan 1; Iowa 1; Virginia 1; North Carolina 2; South Carolina 1; Georgia 2; Florida 1; Texas 1; Colorado 1; Washington 1; California 4.

⁴ Delayed report: Poliomyelitis, Virginia, 1 January case, included in cumulative total only.

Telegraphic morbidity reports from State health officers for the week ended May 10, 1947, and comparison with corresponding week of 1946 and 5-year median—Con.

Division and State	Whooping cough			Week ended May 10, 1947								
	Week ended—		Median 1942-46	Dysentery			Encephalitis, infectious	Rocky Mt. spotted fever	Tularemia	Typhus fever, endemic	Undulant fever	
	May 10, 1947	May 11, 1946		Ame- bic	Bacil- lary	Un- speci- fied						
NEW ENGLAND												
Maine.....	8	6	26									
New Hampshire.....	4		2									
Vermont.....	8	7	7									
Massachusetts.....	117	137	151	1	1		1		1			
Rhode Island.....	26	17	16									
Connecticut.....	32	40	48				2				11	
MIDDLE ATLANTIC												
New York.....	249	161	166	5	1						1	
New Jersey.....	149	161	135			1					1	
Pennsylvania.....	172	116	209				1				1	
EAST NORTH CENTRAL												
Ohio.....	195	73	82								2	
Indiana.....	48	2	12						1			
Illinois.....	80	83	83	8	1				4		13	
Michigan ¹	273	124	124								11	
Wisconsin.....	192	84	84								5	
WEST NORTH CENTRAL												
Minnesota.....	43	10	13								2	
Iowa.....	27	33	18								8	
Missouri.....	49	8	14			2	1	2			1	
North Dakota.....			1									
South Dakota.....	1		2									
Nebraska.....	13		1									
Kansas.....	48	39	39							1	3	
SOUTH ATLANTIC												
Delaware.....	5	5	1									
Maryland ¹	80	19	50			1		1			3	
District of Columbia.....	8	8	8									
Virginia.....	97	110	65	1		93					2	
West Virginia.....	27	51	16									
North Carolina.....	70	65	100	10	1							
South Carolina.....	86	44	57	3	17						3	
Georgia.....	23	12	17						2	4	1	
Florida.....	43	15	15	2						3	4	
EAST SOUTH CENTRAL												
Kentucky.....	31	9	63		1				1			
Tennessee.....	35	8	29	2					2		1	
Alabama.....	67	23	48							1	2	
Mississippi ¹	10								2	2	2	
WEST SOUTH CENTRAL												
Arkansas.....	55	11	9	1		3			1			
Louisiana.....	16	25	4	5					2			
Oklahoma.....	27	7	16						2	1		
Texas.....	854	160	220	12	208	30				14	12	
MOUNTAIN												
Montana.....	4	1	3									
Idaho.....	9	15	7					2				
Wyoming.....	3	4	5				1					
Colorado.....	41	56	37					2			5	
New Mexico.....	66	16	14									
Arizona.....	44	32	28	1		64						
Utah ¹	15	19	32						2		2	
Nevada.....			2									
PACIFIC												
Washington.....	25	28	28	5								
Oregon.....	12	17	21	1							1	
California.....	427	84	265	6	3						7	
Total.....	3,914	1,965	2,576	63	233	194	6	7	20	26	112	
Same week, 1946.....	1,965			35	386	121	3	13	10	30	90	
Median, 1942-46.....	2,576			32	374	84	9	13	18	50	197	
19 weeks: 1947.....	51,914			891	5,536	3,813	127	28	590	716	1,980	
1946.....	23,000			704	5,647	1,989	156	42	339	857	1,553	
Median, 1942-46.....	47,302			560	4,426	1,304	156	42	316	857	1,598	

¹ Period ended earlier than Saturday.

Anthrax: Pennsylvania 1 case.

Botulism: California 1 case.

¹ 2-year average, 1945-46.

WEEKLY REPORTS FROM CITIES ¹

City reports for week ended May 3, 1947

This table lists the reports from 90 cities of more than 10,000 population distributed throughout the United States, and represents a cross section of the current urban incidence of the diseases included in the table.

Division, State, and City	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Pollomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
NEW ENGLAND												
Maine:												
Portland.....	0	0		0	46	0	1	0	2	0	0	9
New Hampshire:												
Concord.....	0	0		0		0	0	0	1	0	0	
Vermont:												
Barre.....	0	0		0	2	0	0	0	0	0	0	
Massachusetts:												
Boston.....	6	0		0	51	0	11	0	20	0	2	26
Fall River.....	0	0		0	13	0	3	0	3	0	0	1
Springfield.....	0	0		0	26	0	0	0	1	0	0	1
Worcester.....	0	0		0	6	0	10	0	4	0	1	7
Rhode Island:												
Providence.....	0	0		0	139	0	4	0	7	0	0	14
Connecticut:												
Bridgeport.....	0	0		0	8	0	2	0	0	0	0	
Hartford.....	1	0		0	66	0	0	0	1	0	0	
New Haven.....	0	0		0	73	0	1	0	6	0	0	10
MIDDLE ATLANTIC												
New York:												
Buffalo.....	0	0		0		0	5	0	9	0	0	2
New York.....	14	0	6	1	329	5	51	2	153	2	1	84
Rochester.....	0	0		0	4	0	3	0	7	0	2	2
Syracuse.....	0	0		0		0	1	0	9	0	0	25
New Jersey:												
Camden.....	6	0		0		0	1	0	4	0	0	4
Newark.....	0	0	1	0	34	0	3	0	10	0	0	26
Trenton.....	1	0		0	19	0	1	0	2	0	0	
Pennsylvania:												
Philadelphia.....	5	0		0	21	3	19	0	47	0	1	44
Pittsburgh.....	1	0	2	2	22	2	6	0	30	0	0	17
Reading.....	0	0		0	2	0	2	0	1	0	0	3
EAST NORTH CENTRAL												
Ohio:												
Cincinnati.....	0	0		1		0	3	0	6	0	0	4
Cleveland.....	0	0		0	191	1	4	1	35	0	0	47
Columbus.....	2	0	2	2	131	0	1	0	4	0	0	14
Indiana:												
Fort Wayne.....	0	0		0	14	0	2	0	3	0	0	3
Indianapolis.....	1	1		0	5	0	5	0	21	0	0	17
South Bend.....	0	0		0	19	0	0	0	3	0	0	
Terre Haute.....	0	0		0		0	1	0	0	0	0	1
Illinois:												
Chicago.....	1	0	2	1	19	0	15	0	32	0	0	44
Springfield.....	1	0		0	52	0	2	0	0	0	0	
Michigan:												
Detroit.....	1	1	1	1	6	0	15	0	47	0	1	105
Flint.....	0	0		0		0	1	0	2	0	0	
Grand Rapids.....	1	0		0	3	0	1	0	4	0	0	9
Wisconsin:												
Kenosha.....	0	0		0	1	0	0	0	2	0	0	7
Milwaukee.....	0	0		0	53	0	5	0	15	0	0	27
Racine.....	0	0	1	1		0	0	0	9	0	0	4
Superior.....	0	0		0		0	0	0	0	0	0	
WEST NORTH CENTRAL												
Minnesota:												
Duluth.....	1	0		0	1	0	3	0	0	0	1	11
Minneapolis.....	4	0		0	8	0	9	0	18	0	0	5
St. Paul.....	0	0		0	437	0	3	0	10	0	0	12
Missouri:												
Kansas City.....	0	0		0		3	10	0	10	0	1	8
St. Joseph.....	0	0		0		0	0	0	1	0	0	4
St. Louis.....	1	0	1	1	22	2	6	0	6	0	0	15

¹ In some instances the figures include nonresident cases.

City reports for week ended May 3, 1947—Continued

Division, State, and City	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Polio-myelitis' cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
WEST NORTH CENTRAL—continued												
Nebraska:												
Omaha.....	0	0		0		0	4	0	2	0	0	5
Kansas:												
Topeka.....	0	0		0	2	0	4	0	9	0	0	
Wichita.....	0	0		0	1	1	3	0	1	0	0	4
SOUTH ATLANTIC												
Delaware:												
Wilmington.....	0	0		0		0	0	0	2	0	0	1
Maryland:												
Baltimore.....	0	0	1	2	21	0	8	0	15	0	0	76
Cumberland.....	0	0		0		0	1	0	0	0	0	
Frederick.....	0	0		0		0	0	0	0	0	0	
District of Columbia:												
Washington.....	0	0		0	25	0	4	0	11	0	0	9
Virginia:												
Lynchburg.....	0	0		0	1	0	1	0	0	0	0	
Richmond.....	0	0		0	52	0	0	0	3	0	1	
Roanoke.....	0	0		0	31	0	0	0	1	0	0	
West Virginia:												
Charleston.....	0	0		0		0	0	0	0	0	0	
Wheeling.....	0	0		0	1	0	1	0	0	0	0	
North Carolina:												
Raleigh.....	0	0		0	2	0	1	0	0	0	0	2
Wilmington.....	0	0		0	2	0	0	0	0	0	0	
Winston-Salem.....	0	0		0	25	0	0	0	2	0	0	
South Carolina:												
Charleston.....	0	0	12	0		0	2	0	0	0	0	1
Georgia:												
Atlanta.....	1	0		0	29	0	10	0	0	0	0	2
Brunswick.....	0	0		0	3	0	0	0	0	0	0	
Savannah.....	0	0	6	0	6	0	4	0	0	0	0	
Florida:												
Tampa.....	1	0		0	4	0	4	0	0	0	0	5
EAST SOUTH CENTRAL												
Tennessee:												
Memphis.....	1	0	3	0	6	0	7	0	1	0	0	10
Nashville.....	0	0		0	1	0	2	0	1	0	0	6
Alabama:												
Birmingham.....	0	0	9	0	40	2	4	0	0	0	0	1
Mobile.....	0	0		0	14	0	0	0	0	0	0	13
WEST SOUTH CENTRAL												
Arkansas:												
Little Rock.....	0	0		2	2	0	1	0	0	0	0	9
Louisiana:												
New Orleans.....	1	0	10	0	45	2	5	2	3	0	0	6
Shreveport.....	0	0		0		0	2	0	0	0	0	
Oklahoma:												
Oklahoma City.....	0	0	4	0		0	3	0	0	0	0	2
Texas:												
Dallas.....	0	0	1	1		0	2	0	3	0	0	7
Galveston.....	0	0		0		0	1	0	0	0	0	
Houston.....	1	0	2	1	4	1	5	0	2	0	1	4
San Antonio.....	1	0		1	6	0	3	0	0	0	0	1
MOUNTAIN												
Montana:												
Billings.....	0	0		0	1	0	0	0	0	0	0	
Great Falls.....	0	0		0	25	0	2	0	0	0	0	
Helena.....	0	0		0		0	0	0	0	0	0	
Missoula.....	0	0	10	0	40	0	0	0	0	0	0	
Idaho:												
Boise.....	0	0		0		0	1	0	1	0	0	
Colorado:												
Denver.....	3	0	1	0	32	0	4	0	10	0	0	6
Pueblo.....	0	0		0		0	1	0	2	0	0	3
Utah:												
Salt Lake City.....	2	0		0	4	0	3	0	7	0	0	4

City reports for week ended May 3, 1947—Continued

Division, State, and City	Diphtheria cases	Erysipelas, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Polymyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
PACIFIC												
Washington:												
Seattle.....	0	0	3	2	26	2	1	0	8	0	0	6
Spokane.....	0	0	0	0	2	0	1	0	0	0	0	1
Tacoma.....	0	0	0	0	0	0	0	0	0	0	0	3
California:												
Los Angeles.....	2	0	2	0	6	1	5	3	38	0	0	36
Sacramento.....	0	0	0	0	1	0	1	0	0	0	1	6
San Francisco.....	0	0	0	0	8	0	4	0	8	0	1	1
Total.....	60	2	80	19	2,291	25	315	8	675	2	14	837
Corresponding week, 1946*.....	68	57	15	11,384	293	946	2	12	462			
Average, 1942-46*.....	64	56	17	6,312	330	1,523	1	14	774			

* 3-year average, 1944-46.

* 5-year median, 1942-46.

* Exclusive of Oklahoma City.

Anthrax.—Cases: Philadelphia 1.

Dysentery, amebic.—Cases: Boston 1; New York 4; New Orleans 6; Los Angeles 1.

Dysentery, bacillary.—Cases: Los Angeles 1.

Dysentery, unspecified.—Cases: San Antonio 4.

Leptosy.—Cases: Galveston 1.

Typhoid fever.—Cases: New Orleans 1.

Typhus fever, endemic.—Cases: Tampa 1; Mobile 1; New Orleans 1.

Rates (annual basis) per 100,000 population, by geographic groups, for the 90 cities in the preceding table (latest available estimated population, 34,602,700)

	Diphtheria case rates	Erysipelas, infectious, case rates	Influenza		Measles case rates	Meningitis, meningococcus, case rates	Pneumonia death rates	Polymyellitis case rates	Scarlet fever case rates	Smallpox case rates	Typhoid and paratyphoid fever case rates	Whooping cough case rates
			Case rates	Death rates								
New England.....	18.3	0.0	0.0	0.0	1,124	0.0	83.6	0.0	118	0.0	7.8	178
Middle Atlantic.....	12.5	0.0	4.2	1.4	199	4.6	42.6	0.9	126	0.9	1.9	96
East North Central.....	4.3	1.2	3.6	3.6	300	0.6	33.4	0.6	111	0.0	0.6	171
West North Central.....	12.1	0.0	2.0	2.0	947	12.1	84.5	0.0	115	0.0	4.0	119
South Atlantic.....	3.3	0.0	31.1	3.3	330	0.0	58.8	0.0	56	0.0	1.6	157
East South Central.....	5.9	0.0	70.8	0.0	360	11.8	76.7	0.0	12	0.0	0.0	177
West South Central.....	7.6	0.0	43.2	12.7	145	7.6	55.9	5.1	20	0.0	2.5	74
Mountain.....	39.7	0.0	87.4	0.0	810	0.0	87.4	0.0	159	0.0	0.0	103
Pacific.....	3.2	0.0	7.9	3.2	68	4.7	19.0	4.7	85	0.0	3.2	84
Total.....	9.1	0.3	12.1	2.9	346	3.8	47.6	1.2	102	0.3	2.1	126

PLAGUE INFECTION IN KITTITAS AND YAKIMA COUNTIES, WASH.

Plague infection was reported proved, on May 5, in a pool of 60 fleas from 108 meadow mice, *Microtus* sp., and a pool of 45 fleas from field mice, *Peromyscus* sp., all collected on April 25 at a location on the top of Umatanum Ridge on the Yakima-Kittitas county line, Washington.

TERRITORIES AND POSSESSIONS

Panama Canal Zone

Notifiable diseases—March 1947.—During the month of March 1947, certain notifiable diseases were reported in the Panama Canal Zone and terminal cities as follows:

Disease	Residence ¹									
	Panama City		Colon		Canal Zone		Outside the Zone and terminal cities		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Chickenpox.....	28	—	2	—	4	—	7	—	41	—
Diphtheria.....	9	1	—	—	—	—	—	—	9	1
Dysentery:	—	—	—	—	—	—	—	—	—	—
Amebic.....	1	—	1	—	1	—	4	—	7	—
Bacillary.....	4	—	—	—	2	—	—	—	6	—
Encephalitis, lethargic.....	—	—	—	—	1	—	—	—	1	—
Leprosy.....	—	—	—	—	—	1	—	—	—	1
Malaria ²	7	—	7	—	12	—	33	2	59	2
Measles.....	8	1	—	—	4	—	2	—	14	1
Meningitis, meningococcus.....	—	—	2	—	—	—	1	—	3	—
Mumps.....	—	—	—	—	1	—	—	—	1	—
Pneumonia.....	—	11	—	1	16	—	5	—	16	17
Tuberculosis.....	—	11	—	10	1	2	12	—	14	35
Typhus fever (murine).....	2	—	—	—	—	—	11	—	13	—

¹ If place of infection is known, cases are so listed instead of by residence.

² 8 recurrent cases.

³ In the Canal Zone only.

Virgin Islands of the United States

Notifiable diseases—January–March 1947.—During the months of January, February, and March 1947, cases of certain notifiable diseases were reported in the Virgin Islands of the United States as follows:

Disease	January	February	March
Filariaasis.....	—	2	—
Gonorrhea.....	19	7	15
Hookworm disease.....	3	1	3
Leprosy.....	—	1	—
Lymphogranuloma inguinale.....	1	—	—
Mumps.....	—	—	1
Pellagra.....	—	2	—
Poliomyelitis.....	—	—	—
Syphilis.....	23	9	22
Tuberculosis, pulmonary.....	—	—	1
Whooping cough.....	—	—	2

FOREIGN REPORTS

CANADA

Provinces—Communicable diseases—Week ended April 19, 1947.—During the week ended April 19, 1947, cases of certain communicable diseases were reported by the Dominion Bureau of Statistics of Canada as follows:

Disease	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Chickenpox		45		216	320	17	11	69	90	768
Diphtheria		3		31	1	6	1		1	43
Dysentery:										
Amoebic					3					3
Bacillary				3	1				1	4
Encephalitis, infectious										1
German measles		1		26	49		11	4		96
Influenza		17			6				70	99
Measles		52	1	72	162	246	65	108	428	1,134
Meningitis, meningococcus									1	1
Mumps		22		41	516	51	107	12	209	958
Poliomyelitis			1	1			1		1	4
Scarlet fever		3	1	53	76	7	2	2	8	152
Tuberculosis (all forms)		9	8	148	20	18	13	26	36	278
Typhoid and paratyphoid fever				15					2	17
Undulant fever				3	5			1	1	10
Veneral diseases:										
Gonorrhoea	5	12	25	107	102	26	36	45	66	424
Syphilis	2	16	14	83	65	7	3	16	44	250
Other forms				1					7	8
Whooping cough		19		20	77	34		9	32	191

NORWAY

Notifiable diseases—January 1947.—During the month of January 1947, cases of certain notifiable diseases were reported in Norway as follows:

Disease	Cases	Disease	Cases
Cerebrospinal meningitis	20	Paratyphoid fever	7
Diphtheria	200	Pneumonia (all forms)	3,403
Dysentery, unspecified	2	Poliomyelitis	9
Encephalitis, epidemic	1	Rheumatic fever	201
Erysipelas	482	Scabies	4,804
Gastroenteritis	2,626	Scarlet fever	867
Gonorrhoea	852	Syphilis	164
Hepatitis, epidemic	314	Tuberculosis (all forms)	415
Impetigo contagiosa	3,969	Typhoid fever	15
Influenza	5,335	Undulant fever	3
Lymphogranuloma inguinale	3	Weil's disease	2
Measles	92	Whooping cough	1,914
Mumps	535		

WORLD DISTRIBUTION OF CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER

From consular reports, international health organizations, medical officers of the Public Health Service, and other sources. The reports contained in the following tables must not be considered as complete or final as regards either the list of countries included or the figures for the particular countries for which reports are given.

CHOLERA

[C indicates cases]

NOTE.—Since many of the figures in the following tables are from weekly reports, the accumulated totals are for approximate dates.

Place		January-February 1947	March 1947	April 1947—week ended—			
				5	12	19	26
ASIA							
Burma	C	80	13	2	3	5	
Moulmein	C	2	10	2	3	1	
India	C	5,988	8,800				
Calcutta	C	1,341	1,474	147	433	468	
Cawnpore	C		6		2		
Chittagong	C		1				1
Lucknow	C		2	1			
Madras	C	2					
India (French)	C	37	3				
Indochina (French):							
Cambodia	C	230					
Cochinehina	C	64	57	6	3	9	7
Cholon	C		11			2	
Giadinh	C	11					
Longxuyen	C	6					
Rachgia	C	9	2			4	
Saigon	C	34	44	6	3	3	7
Vinh-long	C	4					
Siam (Thailand)	C	991	531				
Bangkok	C	246	92	44	71	61	

¹ Includes imported cases.

² Imported.

PLAGUE

[C indicates cases]

AFRICA							
Belgian Congo.....	C		14	1	1	1	1
British East Africa:							
Kenya.....	C	6	6		2		
Uganda.....	C		1				
Egypt: Alexandria. ¹	C	115	24				
Madagascar.....	C	9	10				
Union of South Africa.....	C						
ASIA							
Burma.....	C	812	312	18	4	3	
Bassein.....	C	1	1				
Mandalay.....	C	15	2				
Rangoon.....	C	2	6	1	1	1	
China:							
Chekiang Province.....	C	9					
Fukien Province.....	C	35			43		
Amoy.....	C				43		
Kiangsi Province.....	C	6	7			12	2
Nanchang.....	C		7			12	
Kiangsu Province: Shanghai.....	C	28					
Yunnan Province.....	C	16					
India.....	C	19,161	30,970				
Indochina (French):							
Annam.....	C	3					
Cochinchina.....	C	2	1				
Java.....	C	26	7	2	1		
Palestine.....	C	1					
Siam (Thailand).....	C	13	18				
Syria.....	C				6		
Turkey: Akcakale.....	C		5	1	10	2	

¹ Pneumonic.

² For the week ended May 3, 1 case of plague was reported in Alexandria, Egypt.

³ Imported.

⁴ For the period Apr. 1-10, 1947.

⁵ Including 5 suspected cases.

⁶ Includes 2 imported cases in Batavia.

PLAGUE—Continued

Place	January-February 1947	March 1947	April 1947—week ended—			
			5	12	19	26
EUROPE						
Portugal: Azores.....	C	1				
Turkey (see Turkey in Asia).						
SOUTH AMERICA						
Argentina: Santa Fe Province.....	C	2				
Ecuador:						
Chimborazo Province.....	C	1	1			
Loja Province.....	C		2			
Peru:						
Libertad Department.....	C	6	2			
Lima Department.....	C	12				
Piura Department.....	C	48	10			
OCEANIA						
Hawaii Territory: Plague infected rats [†]		1				

[†] Plague infection was also reported in Hawaii Territory as follows: On Jan. 9, 1947, in a pool of 31 rats; on Mar. 20, 1947, in a pool of fleas.

SMALLPOX

[C indicates cases; P, present]

AFRICA						
Algeria.....	C	85				
Basutoland.....	C		1			
Bechuanaland.....	C	14				
Belgian Congo.....	C	1 201	105	47	188	24
British East Africa:						
Kenya.....	C	80	75	11	13	
Nyasaland.....	C	232	112	37	33	4
Tanganyika.....	C	397	314			
Uganda.....	C	65	34	5		
Cameroon (French).....	C	7	1			
Dahomey.....	C	29	1			1 18
Egypt.....	C	79	54	2		
Ethiopia.....	C		17			
French Equatorial Africa.....	C	3				
French Guinea.....	C	70	52			
Gambia.....	C			1	3	
Gold Coast.....	C	364	96	4	9	
Ivory Coast.....	C	437	181			
Liberia.....	C	23	12			
Libya.....	C	599	517		61	91
Mauritania.....	C	22				107
Morocco (French).....	C	37	6		1	
Morocco (Int. Zone).....	C	2	2			
Morocco (Spanish).....	C	14				
Nigeria.....	C	1,271	839			
Niger Territory.....	C	449	545			
Portuguese Guinea.....	C	3				
Rhodesia:						
Northern.....	C	4	2			
Southern.....	C	42	2	2		
Senegal.....	C	6	4			
Sierra Leone.....	C	80	31			
Sudan (Anglo-Egyptian).....	C	1 16	10			1 27
Sudan (French).....	C	156	83			
Swaziland.....	C	10				
Togo (French).....	C	59	18			
Tunisia.....	C	372	69			
Union of South Africa.....	C	65	P	P	P	P

See footnotes at end of table.

SMALLPOX—Continued

Place		January- February 1947	March 1947	April 1947—week ended—			
				5	12	19	26
ASIA							
Burma.....	C	685	954	164	76	90	
Ceylon.....	C	1					
China.....	C	731	474			¹ 154	
India.....	C	7,394	9,524				
India (French).....	C		8				
India (Portuguese).....	C	1	2				
Indochina (French).....	C	531	313				¹ 112
Iran.....	C	6	1		1	1	
Iraq.....	C	1	5				
Japan.....	C	116	67	4			
Malay States (Federated).....	C	1,640	534	114		117	
Manchuria.....	C	4					
Siam (Thailand).....	C	398	244				
Straits Settlements.....	C	78	13	1	1		2
Syria.....	C		1			1	
Turkey (see Turkey in Europe).....	C						
EUROPE							
Belgium.....	C					¹ 16	
France.....	C	12	19				
Germany.....	C	5	6				
Great Britain: England and Wales ¹	C	15	11	1	6 ¹		
Italy.....	C	29					
Portugal.....	C	6	1				
Spain.....	C	13	3				
Turkey.....	C	1	1				
NORTH AMERICA							
Guatemala.....	C	3					
Mexico.....	C	48					
SOUTH AMERICA							
Argentina.....	C	2					
Brazil.....	C	¹ 18	¹ 3				
Colombia.....	C	340	225				
Ecuador.....	C	34	15				
Paraguay.....	C	¹ 82					
Peru.....	C	55					
Uruguay.....	C	¹ 149					
Venezuela.....	C	¹ 206	¹ 117				

¹ Includes alastrim.² For the period Apr. 11-20, 1947.³ For the period Apr. 1-10, 1947.⁴ Includes 1 imported case.⁵ For the period Apr. 1-20, 1947.⁶ For the 4 weeks ended Apr. 26, 1947.⁷ For the week ended May 3, 1947, 1 fatal case of smallpox was reported in Bilston, England.

TYPHUS FEVER*

[C indicates cases; P, present]

AFRICA							
Algeria.....	C	113					
Basutoland.....	C	3					
Belgian Congo.....	C	80	69	5	16	8	
British East Africa:							
Kenya.....	C	2	1				
Uganda.....	C	1					
Egypt.....	C	23	14	4	1	3	2
Eritrea.....	C	168	98	42	12	12	
Ethiopia.....	C		31				
French West Africa ¹	C	1					
Gold Coast.....	C		2				
Libya.....	C	26	39		2	4	5
Morocco (French).....	C	61	19				
Morocco (Spanish).....	C	11			2		
Nigeria.....	C	2	1				
Tunisia.....	C	116	43				
Union of South Africa ¹	C	41	P	P	P	P	P

*Reports from some areas are probably murine type, while others probably include both murine and louse-borne types.

¹ Murine type.² Includes cases of murine type.

TYPHUS FEVER—Continued

Place		January- February 1947	March 1947	April 1947—week ended—			
				5	12	19	26
ASIA							
Burma.....	C	2	1				
China ¹	C	18	5	1	3	1	
India.....	C	5					
Iran.....	C	14	17				
Iraq.....	C	24	32	6	4	14	8
Japan.....	C	395	105	19			
Java.....	C	1					
Malay States (Federated).....	C	7					
Palestine ²	C	14				11	
Straits Settlements.....	C	1					
Syria.....	C	4	4	4	5		
Trans-Jordan.....	C	1	4			3	
Turkey (see Turkey in Europe).							
EUROPE							
Austria.....	C	1					
Bulgaria.....	C	258	111				
Czechoslovakia.....	C	3	3	2			
France.....	C	3					
Germany.....	C	4	2				
Great Britain: Malta and Gozo ¹	C	3		1	3	8	4
Greece ²	C	48	17	7			
Hungary.....	C	169	137	23	21	39	
Italy.....	C	2					
Sicily.....	C	1					
Netherlands.....	C	1					
Poland.....	C	134	53				
Portugal.....	C	1				1	
Rumania.....	C	3,212	3,378				
Spain.....	C	10	15				
Switzerland ¹	C	1					
Turkey.....	C	207	90	11	16	12	6
NORTH AMERICA							
Costa Rica ¹	C	21	10		6		
Cuba ¹	C	2					
Guatemala.....	C	112					
Jamaica ¹	C	2	6			1	
Mexico.....	C	531					
Panama Canal Zone.....	C	2	2				
Panama (Republic).....	C	12					
Puerto Rico ¹	C	7					
SOUTH AMERICA							
Argentina.....	C	4	2				
Chile ²	C	82					
Colombia.....	C	265	159				
Ecuador ²	C	112	40				
Peru.....	C	156					
Venezuela ²	C	10	6				
OCEANIA							
Australia ¹	C	19	12		8		
Hawaii Territory ¹	C	9					

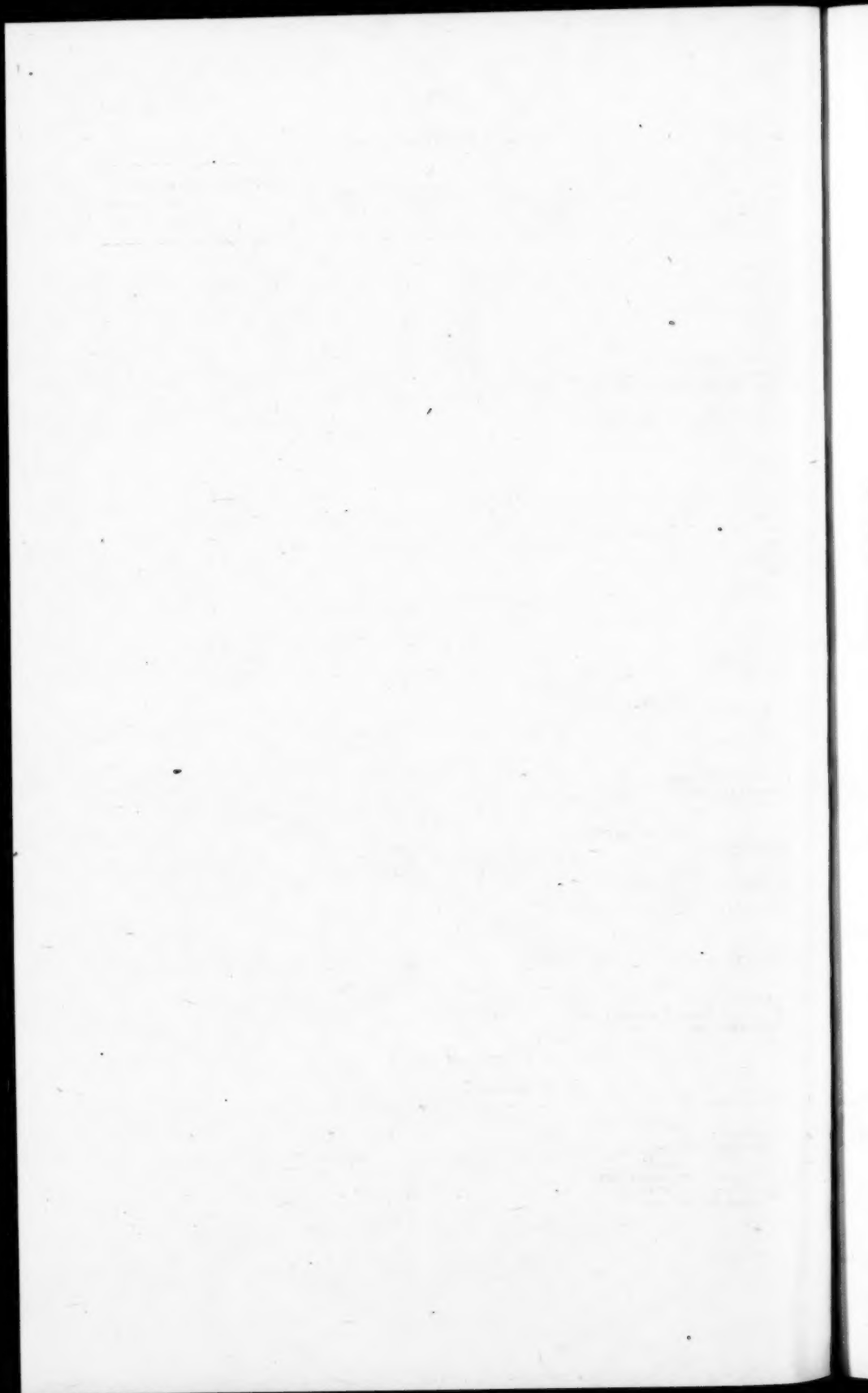
¹ Murine type.² Includes cases of murine type.³ Includes imported cases.

YELLOW FEVER

[C indicates cases; D, deaths]

SOUTH AMERICA							
Columbia:							
Antioquia Department.....	C		3				
Caldas Department.....	D	1					
Cundinamarca Department.....	D	2					
Santander Department.....	D	20	2				
Tolima Department.....	D	2					

X



FEDERAL SECURITY AGENCY
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